HIGHWAY BRIDGE INSPECTIONS

(110–82)

HEARING

BEFORE THE

SUBCOMMITTEE ON
HIGHWAYS AND TRANSIT

OF THE

COMMITTEE ON
TRANSPORTATION AND
INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

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CONTENTS

Page

Summary of Subject Matter vi

TESTIMONY

Andersen, Bart, Level 2 Bridge Inspector, Minnesota Department of Transportation 2
Garrett, Matthew, Director, Oregon Department of Transportation 2
Gee, King, Associate Administrator for Infrastructure, Federal Highway Administration, accompanied by Gary Henderson, Director of Infrastructure R&D, Federal Highway Administration 2
McCabe, Ray, Senior Vice President and National Director of Bridge and Tunnels, HNTB 2
Washer, Glenn A., Ph.D., P.E., Assistant Professor, University of Missouri-Columbia 2

PREPARED STATEMENTS SUBMITTED BY MEMBERS OF CONGRESS

Altmire, Hon. Jason, of Pennsylvania 32
DeFazio, Hon. Peter A., of Oregon 33
Mitchell, Harry E., of Arizona 36
Walz, Hon. Timothy J., of Minnesota 40

PREPARED STATEMENTS SUBMITTED BY WITNESSES

Andersen, Bart 41
Garrett, Matthew L. 45
Gee, King W. 61
McCabe, Ray 99
Washer, Glenn 104

SUBMISSIONS FOR THE RECORD

Garrett, Matthew, Director, Oregon Department of Transportation, responses to questions from the Subcommittee 53
Gee, King, Associate Administrator for Infrastructure, Federal Highway Administration:
- Responses to questions from Rep. Carney 71
- Responses to questions from Rep. DeFazio 73
- Responses to questions from Rep. Napolitano 90

Washer, Glenn A., Ph.D., P.E., Assistant Professor, University of Missouri-Columbia, responses to questions from the Subcommittee 127

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October 22, 2007

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SUMMARY OF SUBJECT MATTER

TO: Members of the Subcommittee on Highways and Transit

FROM: Subcommittee on Highways and Transit Staff

SUBJECT: Hearing on "Highway Bridge Inspections"

PURPOSE OF HEARING

The Subcommittee on Highways and Transit will meet on Tuesday, October 23, 2007, at 2:00 p.m., in room 2167 Rayburn House Office Building, to receive testimony regarding highway bridge inspections. Witnesses scheduled to testify include the Federal Highway Administration Associate Administrator for Infrastructure, the Director of the Oregon Department of Transportation, a level two bridge inspector from the Minnesota Department of Transportation, a National Director of Bridge and Tunnel operations and an academic expert.

BACKGROUND

I-35W MISSISSIPPI RIVER BRIDGE

At 6:05 p.m. on August 1, 2007, the I-35W Bridge in Minneapolis, Minnesota, collapsed into the Mississippi River, killing 13 people. The eight-lane, steel truss bridge span, which was constructed in 1967, carried approximately 140,000 vehicles daily. The National Transportation Safety Board is conducting an investigation into the cause of the collapse. The investigation may take up to 18 months to complete.

In response to concerns over the design of the bridge, U.S. Secretary of Transportation Mary Peters requested that States inspect 756 bridges with a similar steel arch truss design.

It has been widely reported that inspections of the I-35W Bridge raised significant structural concerns with the facility. The bridge had been rated as structurally deficient since 1990, and had

undergone annual inspections by the Minnesota Department of Transportation ("MnDOT") since 1993.

The most recent inspection completed in June 2006 found cracking and fatigue problems, and gave the bridge a sufficiency rating of 50 percent on a scale of 0 to 100 percent. A rating of 50 percent or lower means the bridge should be considered for replacement.

In December 2006, the bridge was to have undergone a $1.5 million steel reinforcement project to strengthen the bridge. However, MnDOT cancelled the project because of concerns that drilling for the retrofit could weaken the bridge. Alternatively, MnDOT implemented a program of periodic inspections to monitor the bridge.

HIGHWAY BRIDGE CONDITIONS IN THE UNITED STATES

According to the U.S. Department of Transportation ("DOT"), one of every eight bridges in the nation is structurally deficient. Of the 597,340 bridges in the United States, 154,101 bridges are deficient, including 73,784 structurally deficient bridges and 80,317 functionally obsolete bridges.

According to DOT, more than $65 billion could be invested immediately in a cost-beneficial way, by all levels of government, to replace or otherwise address existing bridge deficiencies.[1]

The high percentage of deficient bridges and the backlog of necessary bridge repairs are, in part, due to the age of the network. One-half of all bridges in the United States were built before 1964. Interstate System bridges, which were primarily constructed in the 1960s, pose a special challenge because a large percentage of these bridges are in the same period of their service lives (e.g., 44 percent of these bridges were constructed in the 1960s). Concrete and steel superstructures on the Interstate Highway System are, on average, 35 to 40 years old.

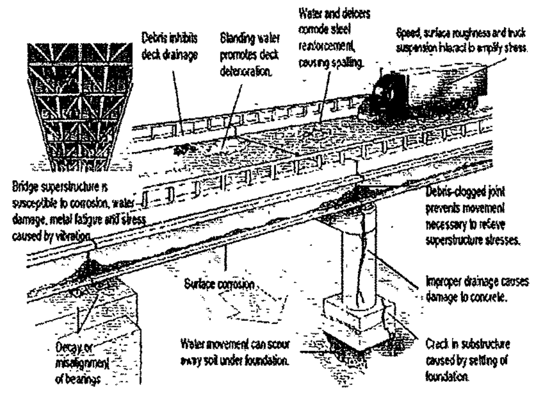
Bridges are considered structurally deficient if significant load-carrying elements are found to be in poor or worse condition due to deterioration and/or damage. The fact that a bridge is "deficient" does not immediately imply that it is likely to collapse or that it is unsafe. With hands-on inspection, unsafe conditions may be identified and, if the bridge is determined to be unsafe, the structure must be closed. A "deficient" bridge, when left open to traffic, typically requires significant maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies.

In a 2006 audit of structurally deficient bridges on the National Highway System ("NHS"), the DOT Inspector General ("IG") illustrated common causes of structural deficiency.[2]

[1] U.S. Department of Transportation, *2006 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance*, January 22, 2007, p. 7-17. The economic backlog of bridge deficiencies consists of all improvements to bridge elements that would be justified on both engineering and economic grounds. It includes improvements on bridges that warrant repair but whose overall condition is not sufficiently deteriorated for the bridges to be classified as structurally deficient. *Id.*, p. 7-16.

[2] U.S. Department of Transportation Inspector General, *Audit of Oversight of Load Ratings and Postings on Structurally Deficient Bridges on the National Highway System*, MH-2006-043, March 21, 2006, p. 2.

HOW BRIDGES BECOME STRUCTURALLY DEFICIENT



Source: Illustration by Jana Brenning. Copyright Jana Brenning. Reprinted with permission. Illustration first appeared in Scientific American, March 1993.

The primary considerations in classifying structural deficiencies are the bridge component conditional ratings. The National Bridge Inventory contains ratings on the three primary components of a bridge: the deck, superstructure, and substructure. Bridge inspectors assign condition ratings by evaluating the severity of the deterioration or disrepair and the extent that it has spread through the component being rated.[3] Condition ratings of 4 and below indicate poor or worse conditions and result in structural deficiencies.

Bridge Condition Rating Categories[4]

Rating	Condition Category	Description
9	Excellent	
8	Very Good	
7	Good	No problems noted.
6	Satisfactory	Some minor problems.
5	Fair	All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.

[3] The condition ratings provide an overall characterization of the general condition of the entire component being rated and an indication of localized conditions.

[4] U.S. Department of Transportation, *2006 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance*, January 22, 2007, Exhibit 3-9.

4	Poor	Advanced section loss, deterioration, spalling, or scour.
3	Serious	Loss of section, deterioration, spalling, or scour have seriously affected the primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	Critical	Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may be removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
1	Imminent Failure	Major deterioration or section loss present in critical structural components, or obvious loss present in critical structural components, or obvious vertical or horizontal movement affecting structural stability. Bridge is closed to traffic, but corrective action may put back in light service.
0	Failed	Out of service; beyond corrective action.

LOAD RATINGS AND POSTINGS ON STRUCTURALLY DEFICIENT BRIDGES

Deteriorating conditions on deficient bridges results in facilities being "load rated". The load rating is an estimate of the weight-carrying capacity of a bridge and is performed separately from the bridge inspection.[5] Properly calculating the load rating of structurally deficient bridges, and, if necessary, posting signs to keep heavier vehicles from crossing them, serves to protect structurally deficient bridges from powerful stresses caused by loads that exceed a bridge's capacity.

In the 2006 audit, the IG found that States erred in calculating the load rating for structurally deficient bridges on the NHS. According to the DOT IG, inaccurate or outdated maximum weight limit calculations and posting entries were recorded in bridge databases of the state departments of transportation and the National Bridge Inventory. The IG projects that among structurally deficient bridges on the NHS:

- one of 10 structurally deficient NHS bridges had load rating calculations that did not accurately reflect the condition of the structure;
- signs were not posted on 7.8 percent of bridges that were required to have maximum safe weight signs posted; and

[5] U.S. Department of Transportation Inspector General, *Audit of Oversight of Load Ratings and Postings on Structurally Deficient Bridges on the National Highway System*, MH-2006-043, March 21, 2006, p. 3.

- procedures were not properly followed in the calculation of load ratings for 10 percent of the bridges.[6]

The IG also found that Federal Highway Administration ("FHWA") Division Offices did not ensure that States' bridge load ratings were properly calculated and corresponding postings were performed. In addition, FHWA does not require its Division Offices to analyze bridge inspection data to better identify and target specific structurally deficient bridges most in need of load limit recalculation and posting.[7]

Federal Bridge Program and Bridge Inspection Standards

In December 1967, the Silver Bridge, which ran between Point Pleasant, West Virginia and Gallipolis, Ohio, collapsed, killing 46 people. The following year, Congress passed the Federal-Aid Highway Act of 1968, which established the National Bridge Inspection Program (NBIP), and directed DOT to work with the States to establish national bridge inspection standards designed to locate and evaluate existing bridge deficiencies to ensure the safety of highway bridges. The Act required DOT to establish inspection criteria and procedures, and inspector training and qualification requirements. The Act also required States to prepare and maintain an inventory of Federal-aid Highway system bridges.

In 1971, DOT published the National Bridge Inspection Standards ("NBIS") in the Federal Register. Under the NBIS, States are required to conduct routine safety inspections on each bridge at least once every 24 months to determine physical and functional conditions of the bridge. The minimum federal requirement of routine inspections consists of "observations and measurements needed to determine the physical and functional condition of the bridge, to identify changes in 'initial' or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements."[8] Routine inspections are generally visual. States, however, often utilize additional technology or mechanical techniques to carry out more in-depth inspections depending on the condition and nature of the structure. Types of inspections include:

- *Initial*—First inspection of a bridge, to provide a structural inventory and a baseline of structural conditions, including identification and listing of existing problems or locations in the structure that may require special attention.
- *Routine*—Regularly scheduled inspections to determine physical and functional condition of the bridge.
- *In-Depth*— Close-up, hands-on inspection of one or more bridge components to identify potential deficiencies not detectable using routine inspection procedures.
- *Special*—Regular inspections to monitor a specific known or suspected deficiency.
- *Damage*—Unscheduled emergency inspection to determine structural damage resulting from accident or other external incident.[9]

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[6] *Id.*, p. 6.
[7] *Id.*, p. 13.
[8] American Association of State Highway and Transportation Officials, *Manual for Condition Evaluation of Bridges*, Second Edition, p. 11.
[9] American Association of State Highway and Transportation Officials, *Manual for Condition Evaluation of Bridges*, Second Edition, p. 11-13.

Information is collected during inspection documenting the conditions and composition of the structures. The periodic inspections determine the adequacy of the structure to service the current demands for structural and functional purposes. Each State's Department of Transportation performs bridge inspections. This information is maintained in the National Bridge Inventory maintained by the FHWA.

The Surface Transportation Assistance Act of 1978 expanded the NBIS to include bridges on all public roads, including bridges not on the Federal-aid Highway system. With an expanded inventory of bridges to be inspected, FHWA decided to lengthen the time between inspections. In 1988, FHWA issued regulations extending inspection intervals for certain bridges based on findings and analysis from previous inspections. The inspection interval for these bridges may not exceed once every 48 months. However, States are still required to conduct routine inspections on each bridge once every 24 months unless the state receives approval from FHWA to expand the inspection interval.

According to the FHWA, 83 percent of bridges are inspected once every 24 months, 12 percent are inspected at least annually, and 5 percent are inspected at least once every 48 months.

The Surface Transportation and Uniform Relocation Assistance Act of 1987 required additional inspection requirements for components that are critical to the safety of the structure. This included fracture critical members and underwater structures.[10] Inspections for underwater structures must occur once every 60 months. Under the 1988 rulemaking, FHWA may extend the inspection interval for certain underwater structures based on findings and analysis from previous inspections. The inspection interval for underwater structures may not exceed once every 72 months.

The Secretary uses funds made available for the U.S. DOT's administrative expenses and the Surface Transportation Research Program to implement the NBIS highway bridge inspection program. States use Highway Bridge Program funds to carry bridge inspection activities.

Bridge Inspector Training and Qualification Requirements

Federal regulation currently sets minimum qualifications of the top two levels of personnel responsible for carrying out bridge inspections. Specifically, the regulations set minimum qualifications required for a Program Manager and a Team Leader.[11]

- *Program Manager*—This is the individual in charge of the overall management and supervision of a State's bridge inspection program. Minimum qualifications for the Program Manager includes:
    - Registered professional engineer; or
    - Be qualified as a professional engineer under the laws of the State; or

[10] Fracture critical members are bridge components "whose failure will probably cause a portion of or the entire bridge to collapse." U.S. Department of Transportation, Federal Highway Administration, "National Bridge Inspection Standards," 53 Federal Register, August 26, 1988, p. 32616.

[11] Underwater bridge inspector and the individual responsible for determining load ratings for bridges are also required to have a minimum level of training.

- Have a minimum of 10 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the *Bridge Inspector's Training Manual.*

> *Team Leader*—This is the second level of bridge inspection responsibility. A team leader must be on site during bridge inspections. Team leaders are responsible for planning and performing field inspections of bridges. Minimum qualifications for a team leaders include:
  - Have qualifications specified for Program Leader; or
  - Have a minimum of five years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the *Bridge Inspector's Training Manual*; or
  - National Institute for Certification in Engineering Technologies Level III or IV certification in Bridge Safety Inspection.[12]

Federal regulations do not require "front-line" bridge inspectors to receive a minimum level of training. Many states, however, provide training for all levels of inspectors through the National Highway Institute and/or other state-based organizations offering FHWA–approved comprehensive training and certification programs.

Technology and Research and Development

Visual observation and other traditional means of observation (such as cleaning and scraping, chain drags, and use of sounding rods and hammers) remain the primary methods of conducting field tests of bridge elements. A study released by the FHWA Destructive Evaluation Center in 2001 raised significant concerns over the reliability of visual inspections. The 2001 report found that visual inspections by 49 trained bridge inspectors from around the country of bridges with identified fatigue problems rarely detected defects. In fact, the study found that only eight percent of the inspectors correctly identified a fatigue crack, and many of the inspectors identified non-existent problems.

To supplement and enhance traditional testing methods, state-of-the-art techniques are increasingly being utilized to augment and advance examination of critical or suspect bridge elements. The types of methods being developed and utilized by states include: impact echo, infrared thermography, ground penetrating radar, strain gauges, ultrasonic, eddy current, radiography, acoustic emissions, x-ray technology, and other non-destructive evaluation techniques.

FHWA, industry, academia, the Transportation Research Board, and State DOTs continue to research, investigate, and develop bridge inspection technologies. To assist in this effort, Congress authorized and funded FHWA bridge research efforts as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users ("SAFETEA-LU"). The research is focused on five bridge program areas: long-term bridge performance, innovative bridge delivery, high performance and innovative materials, nondestructive inspection technology, and seismic research.

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[12] American Association of State Highway and Transportation Officials, *Manual for Condition Evaluation of Bridges,* Second Edition, p. 13.

MANAGEMENT SYSTEM

Most states have developed some form of computer-based bridge management programs. These systems are utilized to assist states in managing bridge programs to improve the bridge inspection process and quality of data collected and reported to the National Bridge Inventory (NBI). These systems also assist states in prioritization of system-wide investment decisions based on the needs of the bridges, and tracking the deterioration rate of bridge elements. The bridge management systems currently being utilized by states, however, vary in complexity and capabilities.

In addition to assisting states in managing bridge programs, computerized management systems could provide FHWA with an effective oversight tool. In the 2006 audit, the IG recommended that FHWA utilize the objective data generated from the NBI and state databases to improve oversight and risk assessments of state bridge programs.

WITNESS LIST

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HEARING ON HIGHWAY BRIDGE INSPECTIONS

Tuesday, October 23, 2007

HOUSE OF REPRESENTATIVES,
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,
SUBCOMMITTEE ON HIGHWAYS AND TRANSIT,
Washington, DC.

The Subcommittee met, pursuant to call, at 2:10 p.m., in Room 2167, Rayburn House Office Building, the Honorable Peter A. DeFazio [Chairman of the Subcommittee] presiding.

Mr. HIGGINS. [Presiding.] Welcome everyone. I am not Peter DeFazio. I am here in his brief delay. He will be here.

I want to welcome everybody to the Committee hearing. My name is Brian Higgins. I represent Buffalo, New York, the 27th Congressional District.

We have Ranking Member Petri here as well, and I will read the opening statement on behalf of Chairman DeFazio.

On August 1st, our Nation's eyes were opened wide to the state of our infrastructure with the tragic collapse of the I-35W bridge in Minneapolis. While we don't yet know what caused that bridge to collapse, we drew necessary attention to the needs of our Nation's infrastructure.

This is the second hearing this Committee has held on the state of our bridges since August, and I intend to focus today on bridge inspection standards and types and quality of data collected through those inspections.

There are several issues on which I would like to hear from our witnesses. I would like to hear about whether or not the Federal Government should increase the frequency of baseline inspections or perhaps a risk-based approach utilizing in-depth inspections on a less frequent basis, the way bridge inspections are done in Europe, would that be more appropriate.

A case could be made for more Federal oversight of inspections. Do we need to reevaluate standards for inspection qualifications and training?

I am concerned by the fact that visual inspections are still the primary method used to perform routine bridge inspections. Visual inspections can only get us so far. In today's day and age, technology is revolutionizing the way we do business in many different sectors. The tools we use to keep our bridges safe should reflect our capabilities in the 21st Century. It seems to me we should have better ways of inspecting bridges than using a hammer.

I am also concerned with the 2006 Inspector General's report that found that one of 10 structurally deficient bridges on the National Highway System had inaccurate load rating calculations.

Furthermore, signs were not posted on 7.8 percent of bridges that were required to have maximum safety weight signs posted. That is very troubling.

Finally, on a positive note, according to a recent survey by the American Association of State Highway and Transportation Officials, 24 out of 40 States responded and stated that they go above and beyond the current requirements of the National Bridge Inspection Standards. But if 24 States are surpassing Federal standards, that begs the question, what are the other 16 responding States doing and should we raise Federal standards to match what many States already have in place?

We have enormous opportunity before us to evaluate existing inspection standards and to strengthen the current program to make our system of bridges safer. I look forward to hearing from our witnesses today.

Mr. HIGGINS. Mr. Petri for an opening statement.

Mr. PETRI. Thank you very much.

I am not John Duncan any more than you are Peter DeFazio, but I would like to ask unanimous consent that a statement prepared for Mr. Duncan be made a part of this record and to say that I would like to thank the panel of witnesses for being here today. This is obviously a very important subject.

Technology data, processing technology or sensor technology has moved well beyond where we are in terms of utilizing it in transportation. We don't do sensors very much on trucks unless people pay for it, automatically register their weight and so on, which is a big issue with bridges and overweight vehicles. A lot of things we could be doing to make the system safer and have regulation which was realistically and then actually enforced to make the system last longer.

I look forward to the entire panel's testimony and thank you very much for the prepared statements that you are making a part of the record.

Mr. HIGGINS. Any other Members have an opening statement?

If not, we will proceed to our panel.

Mr. King Gee, Federal Highway Administration, Associate Administrator for Infrastructure here in Washington, D.C., welcome, Mr. Gee.

TESTIMONY OF KING GEE, ASSOCIATE ADMINISTRATOR FOR INFRASTRUCTURE, FEDERAL HIGHWAY ADMINISTRATION, ACCOMPANIED BY GARY HENDERSON, DIRECTOR OF INFRASTRUCTURE R&D, FEDERAL HIGHWAY ADMINISTRATION; MATTHEW GARRETT, DIRECTOR, OREGON DEPARTMENT OF TRANSPORTATION; BART ANDERSEN, LEVEL 2 BRIDGE INSPECTOR, MINNESOTA DEPARTMENT OF TRANSPORTATION; RAY MC CABE, SENIOR VICE PRESIDENT AND NATIONAL DIRECTOR OF BRIDGE AND TUNNELS, HNTB; GLENN A. WASHER, PH.D., P.E., ASSISTANT PROFESSOR, UNIVERSITY OF MISSOURI-COLUMBIA

Mr. GEE. Thank you, Mr. Chairman. Mr. Chairman and Members, thank you for the opportunity to testify on the National Bridge Inspection Program and the Federal Highway Administration's research work on bridge technology and inspections.

With me today is Gary Henderson, Director of Federal Highway's Office of Infrastructure Research and Development.

This is a very important hearing topic in the wake of the tragic collapse of the Interstate 35W bridge in Minneapolis. As the Chairman noted, the cause of the collapse is still being investigated, and we must fully understand what happened so we can make sure that it does not happen again.

Federal Highways is assisting the National Transportation Safety Board to complete the investigation as soon as possible. Examination of the recovered physical members of the bridge is necessary to determine how the bridge collapsed. A computer model developed at our Turner Fairbank Highway Research Center, based on the original design drawings for the bridge, can simulate various failure scenarios which can then be validated against the physical evidence.

As we await the NTSB findings, the Department is taking steps in response to what has been learned so far to ensure that America's bridges are safe. Two advisories have been issued to the States asking that they reinspect their steel deck truss bridges and that they be mindful of the added weight construction projects may place on bridges.

Federal, State and local transportation agencies consider the inspection of the Nation's nearly 600,000 bridges to be of vital importance and invest significant funds in bridge inspections. Since the establishment of the National Bridge Inspection Standards over 30 years ago, methods and technologies for inspections have been continuously evolving under a partnership among Federal Highways, the State DOTs, industry and academia.

The NBIS define by regulation not only the frequency and types of inspections but the procedures to be used in inspecting and rating highway bridges. A "routine" inspection, which is primarily visual, is the most common type and is generally required every two years. The NBIS also define qualifications for inspection team leaders, project managers, underwater bridge inspection divers and individuals responsible for load rating bridges.

Inspection data on bridge composition and conditions are maintained in the National Bridge Inventory. A sufficiency rating is calculated based on the data items on structural composition, functional obsolescence and essentiality for public use. This rating determines funding eligibility for rehabilitation or replacement of a structure and assists States in prioritizing their bridge investments.

This sufficiency rating should not be confused with whether a bridge is safe. Unsafe bridges are closed.

Numerous technologies are under development that have the potential to substantially advance the practice of bridge inspection. Unfortunately, there is no one-size-fits-all approach in the use of non-destructive evaluation and testing. Each technology is designed for a specific purpose and function.

There are also a number of monitoring systems that can be used to provide real-time data and alert the bridge owner to such things as threshold stresses in load-carrying members, excessive movements, crack growth or scour around a bridge pier. However, monitoring systems require customizing for a bridge and do not elimi-

nate the need for regular visual inspections, nor can they fully guarantee against failure of a bridge component.

Federal Highways actively coordinates a National Bridge Research Program with our partners and stakeholders, and that program is focused on three areas: the "Bridge of the Future," the effective stewardship and management of bridges and the safety, security and reliability of bridges.

Our responsibility for research and technology encompasses managing and conducting research, sharing the results of completed projects, and supporting and facilitating technology and innovation deployment, and that is with academia, the State DOTs and industry.

However, in recent years, the funding structure for the Federal Highways Research Program has limited our flexibility to carry out many activities important for a national program. Nonetheless, I can assure you that any findings and lessons that come out of the NTSB investigation will be promptly learned and appropriate corrective actions taken and institutionalized.

Mr. Chairman, thank you again for this opportunity to testify. We will be pleased to answer any questions you may have.

Mr. HIGGINS. Thank you, Mr. Gee.

Our next panelist is Mr. Matthew Garrett from the Oregon Department of Transportation, Director.

Mr. Garrett, thank you.

Mr. GARRETT. I am pleased to be here today and have the opportunity to discuss bridge inspections with you.

In Oregon, as in every State, ensuring the safety and reliability of the transportation system are top priorities. We take our responsibility for inspecting bridges very seriously, and I will tell you this was validated last week when I was out on site with some of my dedicated bridge staff. I can tell you they understand the gravity of the job they have.

The Bridge Inspection Program is a comprehensive set of procedures, and while the Federal Highway Administration sets the standards and monitors State implementation, it is the States that actually develop and execute the program. There are three types of bridge inspections: routine inspections, fracture critical inspections and underwater inspections.

During routine inspections, engineers and trained inspectors look for any signs of deficit or distress. These are the symptoms, both on the external and the internal sides, that they note. Those conditions are documented, monitored, and repairs and recommendations are made if necessary.

A fracture critical inspection is one that requires an inspector to be within an arms-reach of any member that is designated fracture critical: beams, bents, cross members and such. This normally involves access equipment and climbing. This is a very physical inspection.

Underwater inspections are done by a team of divers looking at bridge piers that are in waterways. Oregon's underwater Bridge Inspection Program is one of the oldest in the Country. It dates back to 1964 when we had floods that damaged several of our bridges.

All bridges receive some form of routine inspection. Bridges that are designed to modern standards and are in satisfactory or better conditions are inspected very two years.

The level and frequency of inspection on older bridges can vary greatly. Inspection programs are tailored to each of those bridges. The bridges we look at we base the inspection program on their conditions. In Oregon, we have 78 State-owned bridges and 161 local bridges that are inspected more often than twice a year.

States do use a number of types of inspection techniques. As mentioned, visual inspections are by far the most common, but they are not the only thing. At times, we augment or supplement the visual inspections with magnetic particle methods, ultrasonic testing, acoustic emissions and ground penetrating radar. These techniques require special training as well as special equipment.

In Oregon, we are using special gauges and sensors to monitor the health of certain bridges. Oregon is out in front when it comes to using advanced technology to assess the condition of its bridges.

The Bridge Inspection Program is continuously modified and improved as new knowledge, technologies and standards are incorporated. Increased qualifications for bridge inspectors were updated as recently as January of 2005, as was the inspection interval for fracture critical bridges. In addition to that, States must now have quality control and assurance programs in place.

I am proud to say that Oregon has had a very robust quality assurance program in place since 1994. It far exceeds the minimum Federal requirements. Each year, we select portions of each inspector's work, and it is reviewed by a team of their peers. Passing this ODOT proficiency test is demanding. The scrutiny is intense. We are better for it in the State of Oregon, and we have seen greater consistency and continuity in our bridge reports, better informing our maintenance plans and our long term investment strategies.

Mr. Chairman, let me conclude by saying there is one absolute fact of life: All things will deteriorate. Bridges represent the highest unit investment of all elements on the highway system. Bridge deficiencies can present the greatest danger of all potential highway failures.

The men and women of ODOT's Bridge Inspection Program are committed to maintaining the public safety and confidence in those bridges, protecting that public investment, maintaining a certain and desired level of service, providing bridge inspection proficiency, and providing accurate records and information, again to inform the maintenance plans and our long term investment strategies.

Mr. Chairman, thank you very much for this opportunity.

Mr. HIGGINS. Thank you, Mr. Garrett.

Next to testify is Mr. Bart Andersen, Minnesota Department of Transportation, Level 2 Bridge Inspector.

Mr. Andersen.

Mr. ANDERSEN. Thank you. I want to thank the Chairman and Members of the Subcommittee for inviting me to testify today. I have a larger statement that I would like to have placed in the record.

I am a bridge inspector and a bridge maintenance worker for the Minnesota Department of Transportation, MnDOT, and I am also a member of the American Federation of State, County and Munic-

ipal Employees, AFSCME, Minnesota Council 5. My union represents transportation workers across the United States, and I am here today to explain how bridge inspectors are trained and how we conduct our inspections.

First of all, our two biggest problems are the lack of MnDOT staff and the lack of funds to do the bridge work. MnDOT has only 77 inspectors who are responsible for approximately 14,000 MnDOT bridges. MnDOT policy is to check every bridge at least once every two years, and about 30 percent of our bridges are fracture critical. We are expected to check these fracture critical bridges once a year.

There aren't enough hours in the work day for 77 inspectors statewide to take care of 14,000 bridges the way we should. In addition to bridge inspecting, we have a host of other bridge-related responsibilities that must be performed: patching holes on the concrete decks, repairing railings. We also repair wood and concrete noise walls and retaining walls. We inspect, repair and replace all of our steel support structures for our highway signs, and this is by no means a complete list of the tasks performed by those 77 bridge inspectors.

Recently, MnDOT hired private inspectors to assist with the backlog to help us meet a December 1st deadline that Governor Tim Pawlenty put out for Minnesota. We do not believe this is a long-term solution to the problem. In fact, these private inspectors were hired after the 35W bridge collapse. If MnDOT had a sufficient number of bridge inspectors to begin with, there wouldn't be a need to bring in these private inspectors at a significantly higher cost.

In addition to insufficient numbers of personnel, we are lacking the funding to improve the safety of the bridges. Many of our bridges have reached their 20 year replacement age.

To compound that need for investment, our bridges built since 1950 are, on average, four times larger in size than their predecessors. The weight they hold is much greater as the trucks that are carrying freight these days are carrying that in lieu of trains that used to carry that transport. That means our bridges are under more stress and cost more to replace and preserve.

When employees start a career in bridge maintenance and inspection, they are required to take a one-week course called Concepts for Bridge Inspection. We learn about bridge technology, architecture and key components. Then we attend a two-week training on comprehensive bridge safety inspection, and this course trains us to identify deficiencies and detect what is causing them.

Our inspection program treats bridges differently depending on their condition and design. In Minnesota, we have the four categories that have been mentioned previously. We also have a category that we just call specialized inspections, and these are for bridge hits, high load hits or heightened homeland security inspections.

In closing, please understand that MnDOT doesn't have enough full time inspectors to keep motorists safe. It is impossible for 77 inspectors to check 14,000 bridges throughout Minnesota while still performing all the other tasks that are required of our job. Although we have a backlog of structurally deficient bridges and an

increasing problem with steel fatigue in many bridges, we lack the funding for replacement, repair and preservation.

I am looking forward as Congress considers these issues. I hope you help us solve the problems of insufficient staffing at State Departments of Transportation, and I hope you will help us with the lack of funding in maintaining the transportation infrastructure we currently have.

The work performed by people like me who inspect, maintain and repair bridges is critical to the safety of the citizens who use our bridges every day. As public employees, we are committed to doing everything we can to protect citizens who use those bridges and highways, but we need your support to do our jobs as well as we possibly can.

Thank you for listening. I welcome any questions.

Mr. DEFAZIO. [Presiding.] Thank you.

Mr. McCabe.

Mr. MCCABE. Thank you, Mr. Chairman and Members of the Committee.

Good afternoon. I am Ray McCabe, National Director of Bridges and Tunnel Design for HNTB. HNTB is one of the Nation's leading engineering and architecture firms with particular expertise in the planning and design of transportation infrastructure. I am a licensed professional engineer with over 30 years of experience in bridge planning, design and inspection of all bridge types. I have been involved in designing some of the Nation's most significant bridges and have incorporated the latest technologies when appropriate.

HNTB is also a member of ACEC, the American Council of Engineering Companies, the business association of America's engineering industry, representing over 5,500 member firms across the Country. On behalf of ACEC and the industry, we appreciate the opportunity to testify before you today to discuss issues that contribute to bridge safety.

Bridges are the vital link allowing our transportation system to operate seamlessly across the Country. Over half of our Nation's bridges were built prior to 1964. Of the 600,000 public road bridges in the Country, 74,000, roughly 12 percent, are classified as structurally deficient. While this percentage has declined since the early nineties, progress has been slow and the magnitude of structurally deficient bridges is still clearly unacceptable, even understanding that deficient bridges does not imply unsafe.

The I-35 bridge collapse in Minneapolis was a national tragedy and wake-up call on how we invest in our Nation's bridges. While we certainly do not know the cause of the I-35 bridge collapse, we do know that the bridge was inspected according to Federal standards. The engineering community anxiously awaits the findings of the NTSB to determine what corrections need to be made to our design, construction, inspection and maintenance practices.

Clearly, we need to make improvements to our Bridge Inspection Program. Improving inspection procedures and techniques will allow us to better allocate available resources. However, it is important to remember that the information gathered from inspections must be applied to a well funded and focused program of bridge repair and replacement to prevent future disasters.

Maintaining our Nation's bridges in a cost effective manner and ultimately ensuring the safety of the people who travel them requires adequate funding combined with the following three components:

Improvements to our bridge inspection and rating system. The National Bridge Inspection Standards enacted in 1974 have served us extremely well. FHWA has been very diligent in updating standards to meet changing needs and technology as well as understanding of bridge problems. Nonetheless, we know that the process is not perfect. Bridge inspections are generally visual which lead to subjective determinations of bridge conditions.

An FHWA study indicated that in-depth inspections are unlikely to identify many of the specific defects for which they are prescribed. The study found that less than 8 percent of inspections successfully located weld cracks and other implanted defects in test bridges.

Furthermore, the study revealed the inspection ratings were highly variable and dependent on such things as bridge inspectors' condition and training, inspection site conditions and accessibility, structure complexity, and available funding. Many factors go into the calculation of sufficiency rating, and thus a bridge that is rated structurally deficient may still be completely safe.

Visual inspection practices must be supported by rigorous training, certification and quality assurance programs and supplemented with testing techniques where necessary to ensure reliable results.

Additionally, the emerging field of structural health monitoring holds much promise for real-time evaluation of structures and objective evaluation of bridge conditions. Providing more quantitative data to bridge program managers will enable them to more accurately rate bridges which will allow States to effectively allocate bridge rehabilitation dollars.

Two, a dedicated methodology to allocate funding for structurally deficient bridges. More money is definitely a necessary part of the solution. However, any money targeted to fix our Nation's structurally deficient bridges needs to be spent based on safety and prioritized using a rational approach.

Funding must be established based on accurate and consistent data, used strategically and stretched over as many deficient bridges as practical. This can be accomplished only by prioritizing our bridges and the individual repairs necessary to advance the most critical bridges out of the deficient category. As indicated earlier, improved inspection techniques will facilitate this approach.

Such a system may have focused more resources on non-redundant welded bridges. These bridges must be given special attention because we know that non-redundant bridges pose a higher risk of sudden bridge collapse from failure of an individual member. We have the technology to analyze failure scenarios and use the resulting data to determine bridge inspection methodology and retrofit techniques to reduce risk of bridge collapse.

Finally, applying advanced technologies, techniques and materials. New bridge designs and rehabilitation of existing bridges must make full use of innovative technologies and more durable materials. Resiliency is the key. Today's bridges need to diffuse

loads and absorb stresses more effectively. They need to be able to withstand abrupt forces more readily and with less resultant damage.

We need to incorporate high performance concretes and steels into new spans and into the structural renovation of existing bridges. Innovative rapid construction techniques should also be considered to minimize inconvenience to the traveling public.

The probability of a bridge failure is extremely low. However, it is not zero. It should be, except for failure due to extreme events.

The way to insure the safety of our Nation's aging bridge infrastructure is not just additional funding or rigorous inspection or advanced technologies alone. It is all three put to a concerted use. Let's not wait for the next failure.

Thank you for the opportunity to provide my testimony. I look forward to your questions.

Mr. DEFAZIO. Thank you, Mr. McCabe.

Dr. Washer, we are going to have to hold your testimony. We have a series of three votes. There is five minutes left until the next vote. So we should hopefully be back in about 20 minutes.

On that, the Committee stands in recess.

[Recess.]

Mr. DEFAZIO. Back to order. We left off with Dr. Washer's testimony. Thank you for your indulgence with the schedule here.

Dr. Washer, please, go ahead.

Mr. WASHER. Chairman DeFazio, Congressman Duncan and Members of the Subcommittee, good afternoon.

My name is Glenn Washer, past Chair of the Committee on Bridge Management, Inspection and Rehabilitation of the American Society of Civil Engineers and Assistant Professor at the University of Missouri-Columbia. I am a licensed professional engineer in Virginia.

I am testifying today on behalf of the American Society of Civil Engineers, the Country's oldest national civil engineering organization representing more than 140,000 civil engineers. We would like to thank you for holding this hearing.

My testimony today will attempt to provide some explanation of the nature and role of non-destructive evaluation or NDE within the context and condition assessment of highway bridges. NDE technologies describe a class of technologies intended to characterize the conditions of materials and structures without causing damage. Visual inspection is the most common form of NDE. More advanced NDE methods frequently depend on characterizing waves propagating within a material to detect anomalies which may be hidden from view.

[Slide shown.]

Mr. WASHER. A familiar example to most people is a medical sonogram which uses acoustic waves launched from a transducer on the surface of the skin to assess conditions within the body, for example, the existence of a fetus in the womb of a pregnant woman as shown in this image.

The image is an indirect measurement of the fetus based on its effect on a propagating wave such that uncertainty can exist. For example, the single fetus shown in this image was later discovered to actually be twins.

[Slide shown.]

Mr. WASHER. In a similar manner, acoustic waves can be used to detect flaws in bridge members by a technique known as ultrasonic testing. This figure shows an image of internal flaws in a weld. The bottom image represents the results of ultrasonic testing. The top image shows a radiograph or x-ray image of imbedded flaws.

NDE methods such as these can provide powerful tools that increase the ability to understand the condition of bridges and improve bridge safety.

There are many NDE techniques available depending upon the type of bridge you are assessing. For concrete bridges, NDE methods such as sounding, impact echo, ground penetrating radar and infrared thermography are available among others. NDE technologies for steel bridges include dye penetrant, magnetic particle, ultrasonic testing, eddy current testing and acoustic emission.

The role of NDE technologies has traditionally been limited in terms of routine inspections of highway bridges. This is due in part to the reality that the data generally required to complete an NBIS inspection does not require NDE. However, that does not mean that NDE technologies are not used for the condition evaluation of bridges by State Departments of Transportation.

A significant challenge to the application of NDE technologies is providing reliable quantitative results under a variety of experimental conditions. Although the capability to detect certain types of defects or flaws may exist, the reliability of that process under real world conditions must be established.

This has proven difficult in a number of cases due to the challenging environment experienced during bridge inspections. Widely varying materials, designs and construction practices may lead to uncertainty in the results of NDE inspections. A broader understanding is required of the complexity of bridge inspections and the application of NDE technologies as a part of those inspections.

An additional complication with NDE technologies in general is that these technologies are intended to detect and characterize flaws. The significance of a detected flaw requires engineering analysis to determine if the flaw has a detrimental impact on the behavior or durability of a bridge and, if so, to also determine the appropriate remediation. This process is complicated if the NDE results include significant uncertainties.

In spite of these challenges, the role of NDE technologies in bridge inspection has been growing. Methods such as ultrasonic testing of bridge pins are in widespread use as are magnetic particle testing, dye penetrant and impact echo, to name a few. These methods are frequently employed within the context of a special inspection where visual inspections have identified potentially problematic areas in need of additional analysis and testing.

Research is required to establish which NDE technologies can provide data that is reliable and produce results significantly beyond what could be accomplished with visual inspections. To date, this remains an elusive goal for many NDE technologies.

[Slide shown.]

Mr. WASHER. This figure is an example of such research in progress. It is a thermographic image of a concrete block with tar-

gets embedded in concrete at depths of one, two, three and five inches. While providing an impressive demonstration of the capabilities of this technology, the practical application of this technology within the context of highway bridge inspections is a subject of research.

Significant research gaps also include effective methods for the condition assessment of prestressed, post-tensioned and cable-stayed bridges where critical structural elements are embedded in concrete such that visual inspections are not possible.

In terms of bridge inspection frequency, it may also be appropriate to explore if a rational approach to establishing inspection intervals based on design, materials, age and condition of specific bridges could result in a more effective utilization of resources that improves bridge safety.

Finally, there exists a need for improved training of engineers in the science of NDE technologies which is multi-disciplinary in nature. Such education and the undergraduate and graduate levels is needed to develop a foundation of knowledge within the engineering community.

This testimony has attempted to provide some explanation of what NDE technologies are and how they are applied within the context of highway bridge inspections. Limitations associated with the complex nature of bridges and their deterioration has been described. There exists tremendous potential to improve bridge safety and maintenance through the proper application and use of NDE technologies, and additional research and development is critical to realizing that potential.

Successfully and efficiently addressing the Nation's transportation infrastructure issues will require long term, comprehensive nationwide strategy including identifying potential financing methods and investment requirements. For the safety and security of our families, we cannot afford to ignore this growing problem.

Thank you, Mr. Chairman. That concludes my statement. I would be pleased to take any questions.

Mr. DEFAZIO. Thank you. I thank all the witnesses.

We will now proceed to a round of questions.

First to the Federal Highway Administration, I guess my first question would be, does the Federal Highway Administration believe that routine visual, periodic visual inspections should continue to be the primary method employed by bridge inspectors?

Mr. GEE. Thank you, Mr. Chairman.

Yes, we do because it has been shown that it has been reliable all these years and, as Mr. Garrett said earlier, we have been evolving the technology and the methodologies, so we are pretty confident that it is still a cost effective inspection technique.

Mr. DEFAZIO. But we have the study in 2001 that showed that trained bridge inspectors doing visual inspections from around the Country, bridges identified with fatigue problems, found only 8 percent of the inspectors correctly identified fatigue cracks, and you are saying that just because of enhanced training or awareness, situational or something, that suddenly that 92 percent is now on the ball here?

Mr. GEE. Well, that study was an internal Federal Highway study, and it was a small sample. I would be very careful.

Mr. DEFAZIO. Right. Have we replicated it as a larger sample?

Mr. GEE. It has not been.

Mr. DEFAZIO. What?

Mr. GEE. It has not been replicated yet.

Mr. DEFAZIO. No, it has not been. Okay.

Mr. GEE. But based on the findings, partly based on the findings of that study, in 2005, we did tighten up the regulations so that there is now a quality assurance/quality control requirement on the whole program.

Mr. DEFAZIO. Well, AASHTO has a study here. They are not represented directly today, but perhaps you can address it.

AASHTO conducted an informal survey in response to one of the questions asked on September 5th, and 40 States responded. We haven't had a chance to identify who that universe is. Twenty-four of the States exceed National Bridge Inspection Standards. Depending on how the rest of it breaks down, if it continues proportionately, it would be over half up to three-fifths of the States exceeding the standards.

Does that cause you some concern or are you just defending the basic minimum Federal standards and saying those are more than adequate?

Mr. GEE. It all depends on what you are using it for. I think for the safety of bridges in this Country, the standards that we have in NBIS are adequate.

I think the reality is that for the last 10 years the Federal Highway Administration has been encouraging the States to move more and more towards bridge management, management of the assets. In order to do that, the States really do need more detailed information, and so we are encouraged that the States are moving in that direction to collect more data than is required for our National Bridge Inventory.

Mr. DEFAZIO. Now the Federal requirement says that basically there is a mandate. You have to visually inspect bridges once every two years. Is that correct? Okay.

Is there an enhanced Federal mandate for structurally deficient bridges, requiring more frequent review or more in-depth review or a different sort of review of those bridges?

Mr. GEE. Yes, there is.

Mr. DEFAZIO. Would you explain that?

Mr. GEE. If a bridge is found to be deficient to a certain degree, then there is a more frequent inspection.

[Subsequent to the hearing, the witness submitted the following: while the NBIS does not specify exact intervals for any situation where more frequent inspection is required, the NBIS does recognize that there are situations where the Program Manager must determine that more frequent inspections are warranted.]

Mr. GEE. For example, fracture critical, it can go to one year or even more frequent if the State decides that it is that much of a concern.

Mr. DEFAZIO. If the State decides, it is not a Federal requirement.

Mr. GEE. The framework is set up, and the States have to interpret and apply it.

Mr. DEFAZIO. Right, but I think perhaps a little more. Given the experience which triggered this most recent round of scrutiny on bridges, one would think that we might want to be reviewing whether or not that is adequate.

What about these enhanced technologies?

You said something about incentives in your testimony, implementing incentives to increase utilization of advanced technology. What sort of incentives are you talking about that would get enhanced technology out there? We heard about some advanced technology at the other end of the panel.

Mr. GEE. I think the reference directly was about bridge technology as opposed to bridge inspection technology.

Mr. DEFAZIO. Okay, so that is initial construction basically. You are talking about new.

Mr. GEE. And maintenance and management.

Mr. DEFAZIO. Right, okay, but not about inspection technology.

Mr. GEE. On inspection technology, I agree with Mr. Washer in that there is research that yet needs to be done, and so far we have been accomplishing some of that research with pooled funding with the States because our own funding, our own research funding, has been constrained.

Mr. DEFAZIO. Mr. Garrett, you have something that I couldn't fully understand from your testimony about seven bridges that have some sort of enhanced monitoring technology. Could you explain that?

Mr. GARRETT. We have, again supplemental to the visual inspection and just to go back to your earlier question to Mr. Gee, I think it is very similar to a medical examination.

I think Dr. Washer's MRI or sonogram of the child reminded me of a conversation I had with a bridge inspector last week when I was out with him. Bottom line, they use that visual and that touch. It is a very sensory approach, first line of defense, looking for those deficiencies. If they find those, they bring forth recommendations, and they apply certain pieces of equipment to enhance the visual inspection.

So we have a variety of gauges or sensors we put on. Just to name a couple, corrosion gauges, again this is applied down in the coastal area where we measure the electric current between the reinforcement in the concrete.

Mr. DEFAZIO. Is this on a real-time basis or just as you go and inspect?

Mr. GARRETT. As we go, but then we come back. This is one of those things that as we see, we want to make sure the corrosion is not bleeding into the rebar. We have a process called cathodic protection where we coat the bridges with zinc and then charge. We are constantly going back, making sure the zinc is taking the hit of the corrosion. So we have that application.

We have load cells we place on bridges to make sure that the direct load on beams or bearing devices is not compromising the load carrying capacity of the bridge. We don't want that exceeded.

We have deflection gauges that measure the lateral movement and the vertical movements of the various beams. With crack gauges, and certainly this is something that we have placed on bridges going back to a couple of years ago, where we are moni-

toring the growth and the movement of cracks in certain bridges. So we have those applied.

Mr. DEFAZIO. None of these were required by the Federal requirements?

Mr. GARRETT. They are not. They are not.

Mr. DEFAZIO. Are you aware how many other States might be using these sorts of devices?

Mr. GARRETT. No, sir, I am not.

Mr. DEFAZIO. Anybody else want to comment on the adequacy of the current inspection regime and how we might enhance it with technology or any concerns you have about it, frequency? Anybody? It is a pretty open question.

Mr. MCCABE. I truly believe that when we look at our inspection system, that the qualifications of our inspectors have to be tied to the complexity of the bridge and its condition, number one. We need improved training in fatigue and fracture of structures to our inspection staff.

Our inspection frequency needs to be risk-based. We can no longer just set arbitrary limits and durations for bridge inspection. We really need to look at what is the risk of a problem with a certain structure.

Mr. DEFAZIO. How would that be determined? Who would determine the amount of risk and increase the frequency?

Mr. MCCABE. Well, I think we need to come up with a process to determine what the risk is based on a number of factors: the bridge age, is the bridge fracture critical, what is the level of traffic that the bridge sees, are the actual loads that bridge sees much more than we even rate the bridge for. So it would go through a bunch of factors that would enter the risk-based equation.

Mr. DEFAZIO. So you think you would set up some sort of range of parameters, Federally, that then the States would have to consult in terms of determining the frequency of their inspections and/or the depth of the inspections.

Mr. MCCABE. Correct.

Mr. DEFAZIO. Anybody else have any comments to add?

Mr. Gee?

Mr. GEE. Mr. Chairman, I think the notion of risk-based is something that we have already moved towards. As you know, some bridges, especially the newer ones, have inspection frequencies that are four years instead of two years.

Jointly with AASHTO, we sponsored an international scan that looked at the practices in Europe, and we are looking at the results of those.

Mr. DEFAZIO. They are at six years, but they use enhanced technologies.

Mr. GEE. And more in-depth inspection every time. So we are looking at that, and we are working together with AASHTO on where we go with that.

Mr. DEFAZIO. Right, because you don't want to be wasting the time of the inspectors on bridges that are newer, that have redundancy built in and other things, when they have other bridges they should get to. Particularly, Mr. Andersen talks about the problem of just getting around to look at everything they have, meeting the current schedule, let alone any enhanced.

Do you want to comment on that at all, Mr. Andersen?

Mr. ANDERSEN. As I had said before, in my situation, I am on a crew of five people. So if you take two people off to do bridge inspection three days a week, that leaves three people to get anything constructive done as far as preventive maintenance.

That is very difficult to do because, and like I said, out of those three people, they are responsible for setting their own traffic control, transporting all the vehicles and materials out to do any patching or anything like that. At the end of the day, it is not productive for us to have such low level numbers of full time inspectors.

The inspectors we have, we feel they have adequate training. We think they have sufficient information to get their job done thoroughly, but it is only when you have the time to do.

When we have bridge hits, when there is a high load that comes through and hits a bridge, that is it. That decimates any preventive maintenance we can do for sometimes up to two weeks because all our concentration goes to that bridge.

I am a little leery about keeping the emphasis on just the routine annual visual inspections because I mean there are bridges that we do our routine annual visual inspections on that some bearings are 40 feet away. We don't ever look at them, and they are never scheduled to get any in-depth inspection because they are not quantified as a fracture critical bridge. So they don't get the snooper inspections or the bridge unit inspections.

Mr. DEFAZIO. Mr. Henderson, is there anything coming along the pipeline, R&D, that you can see that is going to help us with some of these problems?

Mr. HENDERSON. Mr. Chairman, while we do recognize the value of the visual inspection, as more detailed information is needed, we do recognize that we need to move toward the use of NDE technologies.

One of the programs that we have in place currently is the Steel Bridge Testing program that was authorized under SAFETEA-LU. With that program, we are facilitating the development of NDE technology with the States, and encouraging advances in that particular area. We also are developing a database of commercially available NDE technology as well as prototype information, and with that database we believe that we will be able to provide information to the States that will identify the capabilities of those various types of technologies.

Mr. DEFAZIO. It is always bad when I ask someone from the Administration if they have enough money, and the answer always has to be yes. If Congress, in its wisdom, provided, say in the next reauthorization, more funding for research in these areas, could it be productively spent?

Mr. HENDERSON. Mr. Chairman, at the present time, I think that we are spending our money in a most effective way, and the funds that we are spending in this effective way are addressing our current program needs. As you know, with the designated program, we do have some limited flexibility as to what we can do. However, we do feel that our current program needs are being addressed.

Mr. DEFAZIO. So you came over from the State Department with that. That was a very diplomatic answer. That is good.

Okay, with that, I turn to Mr. Duncan.

Mr. DUNCAN. Thank you, Mr. Chairman.

Mr. Gee, the front pages of the newspapers all across the Country have diagrams and charts and articles about the number of structurally deficient bridges, but a lot of those same articles didn't have the information that we have been given and that you mentioned in your testimony, that the percentage of structurally deficient bridges had gone down from 18.7 percent to 12.1 percent today. No matter what somebody's job is, they should always be trying to improve and get better.

Do you think those figures are accurate and, secondly, do you think that we are doing better in both bridge construction and bridge inspections and do think that percentage is going to continue to decrease in the years ahead?

Mr. GEE. Thank you, Mr. Duncan.

I believe that the numbers do reflect the trend, that we have been, in fact, reducing the number of structurally deficient bridges. I think that we have been promoting the use of improved materials—high performance steel, high performance concrete—and that will keep the bridges lasting longer.

I think that as we go forward into the future, because we have never needed to, we have never been required to, we have never had the focus to look at the performance of bridges as they near the end of their lives, it is hard to project what is going to happen in the future, but we do have an active long term bridge performance research program underway right now, and we will need results from that program to answer your question.

Are we going to continue to gain on the bad bridges or are we going to begin to lose? Right now, we don't have an answer.

Mr. DUNCAN. Let me ask you this. In your testimony, you mention a program in Missouri. I know SAFETEA-LU authorized $15 billion in private activity bonds. I didn't get to hear your testimony, but I take it that you are impressed by this Missouri program or you think it has good possibilities.

Mr. GEE. We are impressed. Yes, we are impressed because it is an innovative approach to a huge problem. As you may know, it is 800 and some bridges that the State of Missouri is trying to bring to a satisfactory condition within 5 years and then to maintain it for another 25, all with private investments that will be paid out over time in what we call "availability payments."

The point of innovation there is that the private consortium will be required to maintain the bridges at a certain condition, and I think that is where the innovation is. It is to be responsible for maintaining the bridge as opposed to reacting to a bridge when it becomes deficient.

Mr. DUNCAN. All right.

Mr. Garrett, in your testimony, you mention that the Oregon Department of Transportation has greatly increased the requirements for bridge inspectors, the qualifications and so forth. Are you seeing results from that? These better qualified inspectors, are they finding more flaws or what have you found from those increased qualifications?

Mr. GARRETT. Sir, the first thing that jumps out is the consistency of the reports across the State of Oregon with different geo-

graphical challenges across the State of Oregon but again with this peer review, and that is what it is. It is bringing folks in to oversee and literally scrutinize the inspection reports of the previous years. We are seeing continuity and consistency in what is coming back to us.

We think that is yielding better results, and we have seen over the last couple of years a 2 percent increase in the improvement of our bridge conditions. We see that gradually playing itself out over the next five, six years until some of the investments we have at the State level and some of the investments that came from this Committee play themselves out.

Again, we are identifying it. We are looking at it specific to structurally deficient bridges. We know we have 203 structurally deficient bridges on the State Highway System, 99 of those on the National Highway System, NHS. As we forecast out to 2011, we will be able to repair or replace 67 of those 99. So two-thirds of those bridges will be moved up.

Now again, it is a fluid situation because bridges do deteriorate and move on.

We think we are identifying the problem. We think we have people that bring a little more experience and wisdom because they are engaged and tested, and we have seen a benefit in the State of Oregon because of that.

Mr. DUNCAN. I think the only thing you need to be careful about is everybody is all for better qualified people and continuing education and training and so forth, but you don't want to give people so much training that they are not out inspecting bridges. There is a balance there.

Mr. GARRETT. Sir, I completely agree with you, but my people are thirsty are training. But I certainly understand we want them on the ground, eyeballing the bridges.

Mr. DUNCAN. Mr. Andersen, you mention that Minnesota's 77 bridge inspectors cannot be expected to inspect 14,000 annually. I don't know this. Is Minnesota's ratio of inspectors to bridges roughly what other States have and, secondly, how many inspectors do you think you really need to inspect those bridges?

As Mr. Gee said a while ago, this raises the question I am probably going to get into with maybe one of the other witnesses. With improved bridge construction, do you need to inspect a brand new, well built bridge as frequently as you would an older bridge that perhaps needs more work?

Mr. ANDERSEN. As far as our ratio to other States, I guess I don't have the answer to that, but I think there is a difference in the fact that the majority of our inspectors, the vast majority, are not just full time bridge inspectors. We are required, when we are not bridge-inspecting, every other day to do preventive maintenance and repairs off bridges. So there is a multitude that we are responsible for outside of just bridge inspection.

I mean I guess to throw out a number, I don't know what an accurate number would be to say this is now many would be able to fulfill the duties of a demand like we just got to have every bridge in the State inspected by December 1st. If we had 150 inspectors, I don't know if we could have met that deadline either.

Some of those bridges had been inspected within the year, but we were instructed they get inspected again. When demands come out like that, I don't know there is a number out there that we could have on an everyday basis that would still cover something like that.

Like I said, our biggest struggle is we don't just do bridge inspections. If that was the case, 77, maybe that is an adequate number. I don't know.

Mr. DUNCAN. Well, Mr. McCabe, you have a better targeting of funding for bridge repairs and improvements and so forth, and I suppose everybody is for that.

In an earlier hearing on this subject, I mentioned that my own State of Tennessee, after a bridge collapse in 1988, started spending a lot of money on bridges and because of that, where the national average is, I think, 12.7 percent or something like that, I think we are down 6 percent. We are about half the national average. How do you do that?

If you target the funding to the States that haven't done very much, then it looks to me almost like you are rewarding States that haven't done what they should have done and you are punishing States like mine where the bridges are in better shape. So how do you handle that and be fair about it?

Mr. MCCABE. I think it is certainly clear that more funding is necessary to attack structurally deficient bridges. I think we need to come up with a process to be fair on how we distribute those funds. For example, I truly believe that if we were to look at deficient bridges, we probably ought to assign a time line by which a State needs to turn that bridge around and get it out of the deficient category and, if they don't, perhaps there needs to be a penalty or perhaps they need to use other funding to get it out of that deficient category.

As I look at some of the bridges, and I-35 might be an example, I believe that bridge was on the deficient category since 1990. That is 17 years. We need a process that says I can't let a bridge be deficient for that period of time. Otherwise, maybe there are some penalties that are invoked.

I do agree that that is an issue that some States that are doing the right thing with their funding and their resources are turning their system around, and they should be commended for that, but I don't believe that we ought to use that as a means to say that we don't need to have more funding for a national approach to address the deficient bridges.

Mr. DUNCAN. Dr. Washer, I think you got into this a little bit. Do you think that older bridges need to be inspected more than newer bridges, and how would you handle that?

Mr. WASHER. As I mentioned in my testimony, I think that is something that is worth looking at, whether a time-based inspection frequency makes sense. In many other industries, they are looking at actually participating in inspection cycles and management methods which are based on different things other than time, for example, on risk, to be able to look at what is the probability of a certain type of deterioration and what are the consequences of that deterioration in order to prioritize their inspections and also define their scope.

Through doing that, you are able to liberate resources in order to do more in-depth inspections and possibly utilize assessment technologies like NDE to a higher extent than you could be if you were, say, inspecting all the bridges on the same time line and a frequency based solely on time rather than on condition or on risk.

Mr. DUNCAN. Right. I assume when you are talking about risk, you are talking about what I would assume is bridges that carry more traffic or heavier traffic should be inspected a little more often than those in very rural or remote areas that don't carry much traffic.

Mr. MCCABE. One would expect that to be a component of that analysis along with the types of deterioration typical to that construction of bridge, the year of construction of bridge, knowledge of the deterioration modes are. It is applied in manufacturing industries, this concept of a risk-based inspection.

This particular challenge is the highway bridges based on the fact that there is a wide variety of materials, different constructions, different ages of constructions, which may be unique to bridges. So that is an area, I think, of research that is certainly worth exploring.

Mr. DUNCAN. Thank you.

Thank you, Mr. Chairman.

Mr. DEFAZIO. Thank you, Mr. Duncan.

Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman.

I was a little concerned about Mr. Andersen's statement that the inspectors are also the maintenance workers that actually carry out the corrective actions. It is almost a conflict of interest.

Mr. Gee, do you know if that is a common practice throughout the States?

Mr. GEE. I can't say how common it is, but it does occur.

Mr. MCNERNEY. Mr. Garrett, is that done? Is that what you do in Oregon?

Mr. GARRETT. At ODOT, we have in-house inspectors. We have about seven to nine folks that are specific to bridge inspection, and then we augment with consultants to focus on the local system.

Mr. MCNERNEY. The people who carry out the maintenance are a different set of people?

Mr. GARRETT. That is correct.

Mr. MCNERNEY. Could you describe, Mr. Garrett, the underwater inspection procedure?

I know, for example, the Bay Area, the Bay Bridge has wooden members that are structural members under water. What is the procedure for inspecting under water?

Mr. GARRETT. It literally is a team of divers that go down and look. We are looking for scour, obviously. So we get down there, and we just look for any deficits that are identified. Again, we have a very specific team that goes out and crawls underneath those bridges.

We conducted, if my memory serves me correctly, roughly 200 underwater inspections over the course of the last year.

Mr. MCNERNEY. Do they have some way to test the steel, the structural integrity of the member?

Mr. GARRETT. Yes, exactly. Again using the term, sensors or gauges, we actually have a measurement of air flow, air pressure. We are looking on there. If it changes, we know something has changed within the pier itself.

Mr. MCNERNEY. How many teams do you have?

Mr. GARRETT. I think we have one team, sir. I don't know the number that comprises the team.

Mr. MCNERNEY. I am not sure who wants to answer this question. How is steel fatigue monitored? How do you determine if a structural member has integrity?

Go ahead, Mr. Washer.

Mr. WASHER. I would be happy to address that. There are a variety of ways to address that. In terms of monitoring, measuring the stresses that are occurring in a bridge has been the practice that has been utilized for 30 years, to go out and instrument a bridge, measuring which stresses are applied via traffic and then measure in terms of the number of cycles and the level of those cycles to estimate what the fatigue life is of a particular defect or a particular bridge.

That technology is quite mature following the Silver Bridge collapse when there was a lot of focus in that area for steel bridges, and so we have the capability to do that.

There is a host of technologies that are able to go out and detect cracks in steel bridges. In one respect, it is because cracking in metals is such a large problem over a broad range of industries, that there are methods from other industries that can be applied to highway bridges.

The American Society for Non-Destructive Testing has a number of methods in which you can become certified for finding flaws in steels and metals and things. So there are a lot of technologies available for detecting a crack inside a steel bridge members.

Methods of implementing that within the context of bridge inspections with the access limitations, the materials involved, the coatings and the other difficult environmental conditions of bridges is really a large challenge. My view would be that the detection of those defects is not as large a research challenge as the appropriate implementation of the technologies within bridge inspection.

Mr. MCNERNEY. A lot of what you are describing is you take some measurements, so you know what the loads are or the stresses too, and then you calculate from the S-N curves or wherever, when failure might be expected.

Mr. WASHER. Right, and that is a way of monitoring for the development of fatigue cracks, and there is a large body of knowledge in that for highway bridges.

One of the things that has to be recognized is that many of the details that were historically problematic in terms of fatigue have been eliminated over the last 30 years in the new designs. So this goes back to whether it makes sense to be inspecting bridges that are 40 years old and which have certain design characteristics which are not beneficial in terms of fatigue at the same rate that you are inspecting a bridge that is 10 years old that has different characteristics in terms of fatigue design as well as the quality assurance and the manufacturing process of that bridge.

Mr. MCNERNEY. Thank you.

Mr. McCabe, you stated, I think, that less than 8 percent of staged problems were identified. Was I hearing you correctly on that, that less than 8 percent of some sort of problems were not identified in regular routine inspection?

Mr. MCCABE. I believe they put out a test to a bunch of inspectors, had some flaws in a bridge, and less than 8 percent of them were identified by the inspection teams.

Mr. MCNERNEY. Those are just routine inspections. They are not the critical fatigue.

Mr. MCCABE. Fracture critical, right.

Mr. MCNERNEY. Those weren't staged then. Those were known problems that were already diagnosed, and inspectors missed them anyway.

Mr. MCCABE. I believe that is correct.

Mr. MCNERNEY. So that is a fairly alarming statistic then.

Mr. MCCABE. I would say that is an area of concern. However, we do know that we have the technology to look at cracks in bridges and assess when a crack will become critical. Generally—and I don't know what the background of that testing was—cracks that are fairly small will take some time before they would become of a critical nature.

I believe our focus really needs to be on the fracture critical bridges. History would tell us that those are the ones that have had the problems. Those are the ones that have had collapses, and we really need a much better risk-based approach to inspection and rehabilitation as well as the potential to add redundancy to our fracture critical bridges.

Mr. MCNERNEY. Thank you. I would look to the structural health monitoring sub-branch of engineering to help us through that sort of decision.

Thank you, Mr. Chairman.

Mr. DEFAZIO. I thank the gentleman with his expertise for those excellent questions. I realize he is an engineer.

Mrs. Schmidt.

Mrs. SCHMIDT. Thank you. This is a general question, perhaps to Mr. Henderson first and then to Mr. McCabe.

In reading your testimony, I have discovered that there is no uniform standard, correct me if I am wrong, for bridge inspection throughout the 50 States, that there seems to be each State having their own opportunity to design their inspections. I know, in some cases, some States have a different rating system. In the case of Minnesota, it is far different of a rating system than it is in Ohio.

My concern is two-fold. One is if you don't have matched requirements. In Ohio, we have bridges that connect with other States. In my district, many of those bridges connect with Kentucky. At least with Kentucky, we have the same rating system, so it is a zero through nine, I think it is, rating system. You can match apples to apples.

My concern, though, is if inspection teams in one State are more proficient in inspecting that bridge than in another State. They have more expertise. They have more training. That same bridge that is connecting the two States may not be getting the same results from the inspections.

What kind of coordination is going on currently? If there isn't, if it is just a handshake kind of a deal, should we at the Federal level mandate more close-knit inspections between States?

Mr. HENDERSON. Congresswoman Schmidt, I believe that King Gee would certainly be in a better position to address that question regarding the uniform standards for bridge inspections.

Mr. GEE. Congresswoman, we do have national standards, and we have had them for about 35 years now. So if there was implication in the testimony that there was not, that was not correct. We have had those national standards, and we have been tightening them over time to take care of scour critical structures, to take care of fracture critical.

We continue to tighten those up as we learn about gaps. For example, we now have a requirement that the team leader for a bridge inspection team be experienced, qualified according to some very specific and objective criteria, and that the team leader must be on site. The whole point of having a National Bridge Inventory is to have the data collected from all 50 States be the same.

Mrs. SCHMIDT. Mr. Gee, the team leader in all 50 States, do they have to have the same educational requirements and experience behind them or is that however the State determines that?

Mr. GEE. There are five ways that a team leader can be qualified, and that is spelled out in our regulations.

Mrs. SCHMIDT. Mr. McCabe?

Mr. MCCABE. I agree with Mr. Gee. I think the standards that are set forth by Federal Highway are quite well documented, and so there are not differences in the standards.

Your point about two inspection teams inspecting perhaps the same bridge and coming up with somewhat different ratings is a fact, and I think it can only be addressed by increased training programs, more focus on training these staffs with specific examples to get a little bit more uniformity. But I think it is a fact of life that we are going to have some spread. In a nine-factored rating system, there is going to be some spread in that.

Is it probably out of the ballpark? I mean is the standard deviation off a little bit? Perhaps, and I think that will only come with some improved training.

Mrs. SCHMIDT. Thank you.

A follow-up question, do you think that we should have a national standard of rating so everyone is on a one to nine basis instead of some folks on a one to fifty basis, so we can clearly look at the ratings of all of these bridges across the United States and figure out where they actually fit instead of trying to recalculate it to see which is severe and which is not severe?

Mr. MCCABE. Yes, I do believe we need a uniform system, and I thought there was one in place. I wasn't aware that some States may not use the nine-point rating system. I thought that was uniform.

Mr. GEE. Some States have their own systems, but they have to crosswalk between what they have and what we have at the national level, so there is consistency throughout the national compliance reviews. We have compliance reviews that our division office in each of the States has to conduct every year. We enforce that compliance that way.

Mr. DEFAZIO. Have you concluded, Mrs. Schmidt? Okay, thank you.

We then turn to Ms. Richardson. Welcome to the Committee and go ahead.

Ms. RICHARDSON. Thank you, Mr. Chairman, and I also want to thank Ranking Member Duncan for holding this very appropriate hearing today. I believe one of the reasons we are here is we are obviously here because we need to have this discussion, but I think the recent collapse of the bridge in Minneapolis has caused us to come to this table again and stress the importance of us covering it.

I have a special issue in this hearing today or a special interest, I should say, because 12 of those 74,000 that have been identified as being structurally deficient, 12 of those are housed in my district alone. So this is something that is of great concern to me.

I have six questions, and then I would like to follow up on what Mrs. Schmidt said because we obviously have a little difference of opinion here.

We have a background document that I will reference that says on page eight: most States have developed some form of computer-based bridge management programs. These systems are utilized to assist States in managing bridge programs to improve the bridge inspection process and the quality of data collected and reported to the National Bridge Inventory. These systems also assist States in prioritization of system-wide investment decisions based on the needs of the bridges and tracking the deterioration rate of bridge elements.

The bridge management systems currently being utilized by the States, Mr. Gee, however, vary in complexity and capabilities. So you hear several questions. I am hearing you saying they are standardized, and yet we have two references on both page eight and on page seven that say that both the training and the systems that are being used are not consistent. They either are or they aren't, which one is it?

Mr. GEE. There are two things in view here. One is the bridge inspection process and the rating system. That is standardized. What we refer to as a bridge management system, that is not standardized.

Ms. RICHARDSON. Okay, so that helps clarify that. Thank you very much.

My further questions are, number one, first of all to Mr. Gee, regarding the I-35 Mississippi River bridge situation, who or what organizations are potentially liable for that situation?

I am a new Member.

Mr. GEE. The Federal Highway Administration does not own any bridges. Actually, we had one that I think we are just rid of, the Woodrow Wilson Bridge. The States and local governments and other Federal Agencies own the bridges. So it is the owner agencies that are liable.

Ms. RICHARDSON. Okay, thank you.

Could you provide for us, and maybe you have already but I haven't received it, a list of all the steel arch truss design bridges in the U.S. that had similar designs as what recently collapsed?

Mr. GEE. Okay, there is a list of about 700. You want the list?

Ms. RICHARDSON. Yes, by State.

Mr. GEE. We will be happy to provide that.

Ms. RICHARDSON. Thank you.

My third question is could you also provide us with a list of all the bridges that were noted in the IG's 2006 audit that noted there were miscalculations in terms of loads, load rating, and also that didn't provide signs of the maximum weight allowed?

Mr. GEE. That study, or audit, was conducted by the Inspector General of the U.S. Department of Transportation. We don't have his records, so I think the best thing that we can do is to talk to him, to ask him to provide those to you.

Ms. RICHARDSON. Could you, please?

Mr. GEE. Yes.

Ms. RICHARDSON. Thank you very much.

Question number four, which line item in the Department of Transportation budget reflects the inspection, repairs and ongoing maintenance?

In the background information we received, it talks a lot about funding for inspections but very little discussion about the actual ongoing maintenance required. So if you could just advise of where that would be in the line item budget.

Mr. GEE. In our Federal Highway program, the main focus over the majority of the last 50 years has been capital construction. It is only in the last couple of reauthorizations that we have shifted to maintenance. Even then, it is not routine-routine maintenance. It is heavier rehabilitation maintenance, preventive maintenance.

But under SAFETEA-LU—and this Committee did accept our recommendation and I am very much appreciative of that—under the Highway Bridge Program, there is now a preventive maintenance element that can be used. In other words, Highway Bridge Program monies can be used for preventive maintenance activities if it is part of a systematic bridge management framework.

Otherwise, the routine maintenance of bridges is up to the States and the local governments, but there is not a specific line item for maintenance per se.

Ms. RICHARDSON. How much is in that account that you referenced?

Mr. GEE. The Highway Bridge Program?

Ms. RICHARDSON. Yes.

Mr. GEE. About $4 billion a year.

Ms. RICHARDSON. I think it was noted in our material that in the one area alone $63 billion was needed to address some of the structural issues that we have.

Mr. GEE. That is the backlog of bridge needs right now. Based on the Conditions and Performance Report analysis, to maintain where we are would require about $8 billion a year over the next 20 years to just maintain the condition of bridges where they are. I would point out that in 2004 at all levels of government, the total spending was $10.5 billion. So we are spending more than what the C&P report says we need to maintain our condition.

Ms. RICHARDSON. Okay. Last question because I see my time is wrapping up here, on the map that was provided from the Department of Transportation that shows the bridges by district, it was interesting in my area the Gerald Desmond Bridge was not high-

lighted. The Gerald Desmond Bridge is along 47 right on the coast there, and it is in such bad shape that there is actually what they call a diaper that is underneath it to catch the falling pieces of concrete.

If you could follow up with my office and this Committee as to why that bridge isn't included, what is its current status, so I can more appropriately be advocating on what is happening there.

Then my final one is we were provided a list of bridges that have deficiencies in our districts, but they don't include what the structural rating, so if that could be provided as well.

Mr. GEE. Yes, we will do that.

Ms. RICHARDSON. Thank you very much.

Thank you, Mr. Chairman.

Mr. DEFAZIO. I thank the gentlelady for her questions. I think she is an excellent addition to the Committee, and doing a fine job.

Mr. Boozman.

Mr. BOOZMAN. Thank you, Mr. Chairman. Thank you for holding this hearing on this particular subject which is so important.

I guess we had a failure of the bridge, but we had a failure of the inspection process in the sense that nobody envisioned that bridge collapsing. So I guess since there was a failure of the inspection process or a failure of the inspection, I would like to know what you want to do differently as far as the process because if you don't have a very, very reliable way of identifying the bridges that are in trouble, then it doesn't matter if you stick more resources in there. You are not sticking them in the right direction.

If we ranked bridges that people felt like were imminently in the worst shape, I think most of the people I have talked to and most of the people who have testified would not say that based on the inspection, that this bridge would be at the top of the list.

The other thing is that there is some concern, I know, about perhaps that there was something that contributed as far as the work on the bridge and weight placements on the bridge when work was going on and stuff. I would like to know your opinion as to whether or not, short term right now, if any word is being disseminated as to whether or not that information has gotten out so that we don't duplicate that effect. Does that make sense?

Mr. GEE. Sir?

Mr. BOOZMAN. My sister was redoing the shingles on her house. Well, they stacked all the shingles on one side of the house and collapsed that portion. That is common sense, but I guess I am wondering if we need to legislate or somehow if we make a rule or how far do we need to go if that is a major part of the deal.

Mr. GEE. To answer your last question first, I would caution against jumping.

Mr. BOOZMAN. I understand. Yet, on the other hand, I would caution if there is strong suspicion that that is the case, then you don't want something to happen in the meantime.

Mr. GEE. Sure, and Secretary Peters, acting out of an abundance of caution, did cause us to take some steps to respond. Now I would hasten to say, first of all, that the exact cause of the collapse of the I-35W bridge in Minneapolis has yet to be determined by the NTSB.

Nevertheless, we did issue two technical advisories. One was immediately after the collapse. We asked all States to reinspect that type of bridge.

Secondly, when we found out that construction loadings, your point, might be a factor, we asked and reminded all the States to keep that in mind. It is already a requirement, when they design work on a bridge, to take into consideration all the loadings during the construction phasing. That is an actual standard, and so we just reminded the States to keep that in mind.

Mr. BOOZMAN. Does somebody actually look at that during that? I mean is there a bridge inspector as it goes on?

Mr. GEE. Not an NBIS bridge inspector as it goes on. It is as a project is designed, the structural engineers need to look at the loadings that will be on that bridge during the construction time.

Mr. BOOZMAN. Okay. How about the first question about the fact that again nobody really anticipated that bridge to collapse based on the information that we had?

Like I say, if we had resources, and I think we are all committed to try and get more resources into bridges, the fact that that bridge probably would not have been on the top of list as far as putting more resources into it.

Mr. DEFAZIO. While they are queuing up to answer that question, I forgot to recognize that Mr. Garrett has to leave at 4:00 to catch a plane. I know how difficult it is to get to Oregon. So, Mr. Garrett, if you have to leave, if you want to address his question before you leave, you could. If you don't, you are dismissed.

Mr. GARRETT. I will defer to my friends.

Mr. DEFAZIO. There you are.

Mr. GARRETT. Mr. Chairman, thank you for the opportunity.

Mr. BOOZMAN. It is okay, Mr. Chairman. It doesn't seem like we have a whatever to get it done, but I do think that is an important distinction. Like I say, we are committed to try and put resources in, but if you are putting based on the information that we currently had, we would be putting resources in the wrong place in the sense, like I say, that bridge would have collapsed based on the inspection thing.

I know the fact that we have gone and reinspected. The other question I would have is in these re-inspections that we have done, were there any surprises or were there a lot of surprises out there that automatically placed them from the middle all the way up to the top or vice versa?

Mr. GEE. You asked two questions there. The first one is there were no real surprises of the almost 700 bridges of that same type that were reinspected. We are about 96 percent done with the reinspections, and the rest should be done by the middle of November. But out of the ones that have been already done, there were three States that found problems with some bridges, but all told there were only six bridges altogether that had a problem that had not been caught in previous inspection.

Now as to whether any of the reinspections cause a bridge to be ranked higher, I cannot answer that question.

Going back to your other earlier question, the I-35W bridge was programmed by Minnesota DOT for reconstruction of some type. It just hadn't gotten there yet.

Again, without knowing why it collapsed, we cannot say that it was an inspection failure. It was a failure. We just don't know what failed.

Mr. BOOZMAN. Thank you, Mr. Chairman, very much.

Mr. DEFAZIO. Thank you, Mr. Boozman.

With that, I would turn to the Chairman of the Full Committee. Everyone else has gone, Mr. Chairman. It would be your prerogative.

Mr. OBERSTAR. Thank you very much, and I apologize for not being here at the outset of the hearing. I had a speech to the International Aviation Club about the status of our Aviation reauthorization Bill, the U.S./E.U. aviation trade relations and the future of investment in airport modernization, and upgrading and modernization of the air traffic control system. The Q and A period was rather lively.

I just got back to the Hill, and the votes were underway on the House Floor. So I am sorry I have been delayed.

I want to thank you for chairing this second of our hearings on the bridge proposal and for the time and effort that you, Mr. Chairman, have devoted to the subject. You are very bridge-conversant with the unique situation in Oregon, and it has been my pleasure to be there with you to see the situation.

I want to thank all of the witnesses for participating today. I did spend time last night, reading over your testimony.

I want to come back to Mr. McCabe. I made tab notes on your testimony, parts that I thought were particularly significant.

Mr. Andersen, I am enriched by your testimony because of its honesty, integrity, the straightforward statements that you made, unafraid of consequences. I am quite confident that your testimony will not be admired at the uppermost echelon of MnDOT, but I respect it immensely—your candor, your honesty and the factual situation.

You say we have only 77 inspectors for 14,000 bridges. When you point out the exodus of personnel from MnDOT, it has been appalling in these last three and a half years. MnDOT has lost nearly a thousand top-notch professionals.

We have a big transportation program in Minnesota, a robust transportation program. We have a reputation over many years of having the best, one of the best programs of any Department of Transportation in the Country, but in recent years it has gone downhill.

As the best skilled personnel—engineers and inspectors and managers—have left the program and gone to work for a lot more of the private sector, even the private sector has complained the MnDOT doesn't have the personnel to oversee the work and the contracts that they are carrying out.

Now I say in our State—and I have told this to the governor—that we have a lieutenant governor who is commissioner of transportation. Either we don't need a lieutenant governor or we don't need a commissioner of transportation. My view is we need the latter more than the former, and that one person cannot do both jobs and cannot do both of them well and is certainly doing neither well right now.

The observation that MnDOT is out of money is very clear when the governor and the lieutenant governor try to shift the blame or the problem onto the Congress because Congress didn't appropriate the $250 million authorized in the bill that we passed within 48 hours of the bridge collapse. Forty-eight hours, to get a bill through Congress in 48 hours, you can't even pass a prayer in Congress in 48 hours anymore.

To say, well, we can't move ahead because we don't have that whole $250 million appropriated, they know full well that the way the Federal-Aid Highway Program works is that the State pays the contractor and then bills the Federal Government for repayment.

MnDOT's problem is they had only $6 million in the whole transportation account because this Administration has had the entire transportation on auto pilot ever since 1988 when, under the Perpich Administration and two successive legislative sessions, we increased the gas tax a total of 7 cents. We had enough revenue going to cover over through the Carlson Administration, through the Ventura Administration and now into this one.

They have had the luxury to say, well, we don't have to increase the gas tax. All during that time, the value of the construction dollar has been eroding 33 to 47 percent, and you have to replenish those funds in order to be able to make the investments.

When, in your testimony, Mr. Andersen, you say routine annual inspections are typically done without specialized equipment. Visually survey the deck, bearings railings. Fracture critical inspections are done with trucks, scaffolds or man lifts. Underwater inspections are done by private contractors.

Twenty years ago, I held hearings on bridge safety. One of the salient issues raised in those hearings was underwater inspections to be done by seasoned, experienced personnel within the Department. We held that hearing on the 20th anniversary of the collapse of the Silver Bridge in West Virginia when 46 people died to see what improvements have been made in bridge safety. A witness at those hearings, and this is a Ph.D. bridge engineer, said that bridge inspection and maintenance is in the Stone Age across America.

In 1987, I observed at the opening of that hearing, we had 363,000 bridges in America. Today, we have 597,000 bridges throughout the Country. We had 73,000 bridges in 1987 that were structurally or functionally deficient, 73,000 total. Now we have 73,000 structurally deficient bridges and another 74,000 that are functionally deficient.

We can't keep sweeping this problem under the rug and expect the Nation to function effectively. Now the 70,000 or so bridges on the National Highway System that are structurally deficient carry 70 percent of the bridge traffic of the Nation.

There is a financial cost to a bridge being shut down as we are experiencing in Minnesota. When it collapsed, on the south side, it shut down barge traffic. That diverted those commodities, aggregate principally, sand and gravel, to truck traffic. Put another 275 trucks on the road. On the north side, it shut down rail traffic. That put another 50 trucks on the road, 50 to 75, by some estimates.

Now the channel is open. The barge traffic has resumed. The rail will be able to operate. But there is a huge cost, a huge loss.

Now it is going to take longer and be more costly to replace that bridge under a contract that was awarded to the highest bidder, not the lowest bidder, the one that will take the longer time, not the shorter period of time, and with a number of questions hanging over whether there is going to be enough capability to oversee the construction to make sure it is all being done properly because we don't have the personnel, as you point out very well in your testimony.

I thank you for your courage in coming to the Committee and laying it out.

Now let me ask you. I had a meeting with some of your colleagues the week after the bridge collapsed, and I laid out my four-point proposal for the bridge program including raising the standards by which we determine structural deficiency, having more rigorous evaluation of bridges. That may include more bridges that are structurally deficient—I don't know—but I think we need to do that.

Raising the qualifications and training, intensify the training and skills of bridge inspectors and their overseers, establishing a bridge trust fund for structurally deficient bridges.

The fourth item is a dedicated revenue stream with a five cent increase in the user fee in an earmark-free process by which the determination of the structural deficient bridges will be made, verified by the National Academy of Sciences and, once established, will not be tampered with by the National Executive Branch or State Executive Branch or by the Congress. If there is any deviation from the list, then the Secretary of the Treasury will be directed to shut down funding for the whole program.

Now what problems do you see?

This is a three-year program, sunsetted at the end of three years.

What problems do you see along the road for assuring that we have sufficient trained bridge inspectors, trained to the highest level? Where should the funds come from to do that?

What are the issues raised in evaluating and permitting bridges?

What are the obstacles to getting something like this done in a very short time frame to deal, say, 6,000 or so if you make a rough estimate of the most critical structurally deficient bridges? What are the obstacles to getting there?

Let me start with you, Mr. Andersen.

Mr. ANDERSEN. To be quite frank, some of those answers are probably above my pay grade. My biggest concern at this point, to be honest, would be the accountability at the level of management and engineering that make the decisions.

Like I said, I am about as rank and file as it gets. When I go out, if I am involved in an inspection, once my inspection report is done, it is passed on to the engineering level, and that is the last I see of it. I won't get any feedback, whether any of the deficiencies I found or any preventive maintenance items I found need to be attended to immediately. I don't have that decision-making power.

So, like I said, I guess my concerns would lie in the fact that any changes in the system at this point, any new monies allocated to take care of some of these issues, just I would hope there would

be some sort of an accountability factor built in there that there is going to have to be a very adequate recording purpose from your level on down that says these are our expectations; these were things we assumed were going to be looked at and taken care of; where are we at now.

If that is in there, that is wonderful. But I hope all departments are held to that accountability standard because, like I said, when we get to a point where a deficiency rating is given to a bridge which ultimately depends on how some of the funding comes down, at the lowest levels where those ratings are being made, the decision-making and the monies that come back to those problem areas are decisions made far above where I am at. Like I said, it is hard for us on a daily basis to see these problems going untouched.

Mr. OBERSTAR. Thank you. I appreciate that. Accountability is absolutely critical.

Mr. McCabe, you have three items: apply advanced technologies, techniques and materials; a dedicated methodology to allocate funding, which we would address; and improvements to the bridge inspection and rating systems.

Those points that I raised in our draft proposal, is that square with what you are thinking about?

Mr. MCCABE. Very much so, Mr. Oberstar.

I think I would just like to go back to your roadblocks. I think it is very clear that the roadblocks to accomplishing what we need to accomplish are fairly simple: money, prioritization and, as Mr. Andersen said, accountability. We need those three things to enter the equation to get our bridges safe.

Mr. OBERSTAR. Using non-destructive evaluation of bridges, which was in Dr. Washer's testimony, that was an issue raised 20 years ago. It has not been fully implemented across the Country. What is the resistance? Is it resistance or is it simply neglect of using available technologies? We do it in aviation.

Mr. WASHER. Well, yes, it has been an issue for 20 years. There have been a lot of advancements in the last 20 years.

Mr. OBERSTAR. Yes.

Mr. WASHER. Is it used as broadly maybe as it could be used? Maybe not, but there has certainly been a lot of advancements in the number of times, in the frequency of use, and there are surveys of States that demonstrate that that have been published by the Federal Highway Administration. So there has been a lot of progress in this area of implementing NDE technologies.

But I think one of the points that ought to be is that it is not a simple process. It is not simple in aerospace, and it is not simple here. Finding a way to integrate those technologies into the operation has a lot of challenges. Learning the reliability of those beyond just being able to demonstrate a simple capability in a laboratory is a subject of research.

I would find that we have made a tremendous amount of progress in the last 20 years in that particular area, in figuring out what are the capabilities of these different NDE techniques and how to integrate them into our systems.

I will give you, as an example, ultrasonic inspection of bridge pins which is widely used. It wasn't used at all 30 years ago. Learning from experience that we had with failures, now it is wide-

ly used. I would venture that almost every State uses it for pins in their particular State, and various States are looking at advanced ultrasonic technology like phased arrays that have come out of medical industry on how to improve that process.

It is a growing field. There is more research needed, in my opinion, in that particular field. There are a lot of technologies available. If we can figure out how to apply them effectively within the context of a bridge inspection, then there is a tremendous amount of potential there to improve the safety of bridges.

Mr. OBERSTAR. Are you familiar with the application of those technologies by the various State Departments of Transportation?

Mr. WASHER. Generally familiar with it, yes.

Mr. OBERSTAR. Twenty years ago, they weren't applying those technologies, and I have the impression that dragging a chain over a bridge is still a widely applied technology to determine what the sound is and how it sounds to the trained ear instead of using eddy current technology and dye and ultrasound which we use in testing the hull of aircraft.

Mr. WASHER. Yes, there are a few different, I guess, issues to address there. The sounding and chain drags have proven to be extremely effective over the years in terms of cost of assessing concrete which is a heterogenous material, which is very complicated to assess with NDE technologies.

Metals are really a separate thing because metals are much less heterogenous, and so you can use eddy current and ultrasound on them and have more effective techniques.

Now having said that, the sounding and chain drag techniques have been advanced over the years, and there are a lot of flavors of that technique in terms of impact echo, instrumented chain drags and a whole host of others that have been developed. Those are implemented periodically. Sporadically would not be the right term, but when needed with State DOTs, they do implement some of those technologies.

But it is really hard and difficult to compete with sounding and chain drag. In fact, I would submit that most States would measure any new technology according to its effectiveness compared with chain dragging and sounding because that has proven to be a reliable technique within their experience.

Now does that have reliability issues as well? Yes, and the study of those reliability issues is an important factor in the widespread use of newer technologies.

Mr. OBERSTAR. Thank you. I have a ton of other questions, but you have been here a long time and we have votes on the Floor and I have another meeting to attend to.

So I will have to just say thank you and thanks to the Federal Highway Administration for being here. Thanks every so much for your presentations.

Mr. DEFAZIO. Thank you, Mr. Chairman. The Chairman is multitasking as usual.

I want to thank you all for being here, for your testimony today and looking for ways to enhance and improve these programs so we can better protect the traveling public.

With that, the Committee is adjourned.

[Whereupon, at 4:25 p.m., the Subcommittee was adjourned.]

Subcommittee on Highways and Transit

Hearing on "Highway Bridge Inspections"
Tuesday, October 23, 2007

Statement – Congressman Jason Altmire (PA-04)

Thank you, Chairman DeFazio, for calling today's hearing to discuss a matter of critical importance -- highway bridge inspection standards. As we are all aware, improvements to the inspection process are imperative if we are to prevent incidents similar to the collapse of the I-35W Bridge from occurring in the future.

I have concerns regarding the methods currently utilized to inspect our nation's bridges. For a vast majority of bridges, a visual inspection every two years is all that is required for the Department of Transportation to deem them safe for drivers. When one considers the age of our nation's infrastructure, this does not seem to be sufficient. I believe that it is important for this committee to examine what role technology can play in improving our nation's bridge inspections and properly informing the public about the conditions of them.

Additionally, I continue to have concerns regarding the load ratings of our bridges. The Department of Transportation's Inspector General found that one out of ten structurally deficient bridges are incorrectly rated. Moreover, almost eight percent of all bridges required to have safe weight signs posted do not have any such signage. Failing to properly rate our bridges, and in some cases not installing the proper signage, has created a dangerous situation on our nation's roadways.

Chairman DeFazio, I look forward to hearing from each of our witnesses today and once again thank you for holding this hearing.

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STATEMENT OF THE HONORABLE PETER A. DEFAZIO
CHAIRMAN
SUBCOMMITTEE ON HIGHWAYS AND TRANSIT
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

HEARING ON
HIGHWAY BRIDGE INSPECTIONS

October 23, 2007

- On August 1st our nation's eyes were opened wide to the state of our infrastructure with the tragic collapse of the I-35W bridge in Minneapolis.

- While we don't yet know what caused that bridge to collapse, it drew necessary attention to the needs of our nation's infrastructure.

- This is the second hearing this Committee has held on the state of our bridges since August and I intend to focus today on bridge inspection standards and the types and quality of data collected through those inspections.

- There are several issues on which I'd like to hear from our witnesses.

- I'd like to hear about whether or not the federal government should increase the frequency for baseline inspections. Or perhaps a risk-based approach, utilizing in-depth inspections on a less frequent basis, the way bridge inspections are done in Europe, would be more appropriate.

- A case could be made for more federal oversight of inspections. Do we need to reevaluate standards for inspector qualifications and training?

- I am concerned by the fact that visual inspections are still the primary method used to perform routine bridge inspections. Visual inspections can only get us so far. In today's day and age, technology is revolutionizing the way we do business in many different sectors. The tools we use to keep our bridges safe should reflect our capabilities in the 21st century. It seems to me we should have better ways of inspecting bridges than using a hammer.

- I am also concerned with the 2006 Inspector General report that found one out of ten structurally deficient bridges on the National Highway System had inaccurate load rating calculations. Furthermore, signs were not posted on 7.8% of bridges that were required to have maximum safe weight signs posted.

- That is very troubling.

- Finally, on a positive note, according to a recent survey by the American Association of State Highway and Transportation Officials, 24 out of the 40 states responding stated they go above and beyond the current requirements of the National Bridge Inspection Standards.

- My home state of Oregon is one of those states that exceed federal standards and we will hear about their program today.

- But, if 24 states are surpassing federal standards; that begs the question of what are the other 26 states doing and should we raise federal standards to match what many states already have in place?

- We have an enormous opportunity before us to evaluate existing inspection standards and to strengthen the current program to make our system of bridges safer.

- I look forward to hearing from our witnesses today.

Harry E Mitchell

Statement of Rep. Harry Mitchell
House Transportation and Infrastructure Committee
Subcommittee on Highways and Transit
10/23/07

--Thank you Mr. Chairman.

-- I want to once again extend sympathies, on behalf of my district, the good people of Minneapolis who are still coping with last summer's tragedy. They have suffered a great loss, and we stand with them.

--I also want to thank you and Chairman Oberstar for your leadership on this issue.

--When it comes to structurally deficient bridges, Arizona is a relatively lucky state. In fact, the American Society of Civil Engineers has given Arizona an A-minus for highway bridge safety.

--We are a growing state, and a good deal of our infrastructure is new. We are also an arid state, and as a result, our bridges are subject to less decay-causing moisture.

--Still, we need to ensure that what we build is well maintained.

--According to the Bureau of Transportation Statistics, out of Arizona's 7248 bridges, 161 are considered structurally deficient.

--Fortunately none of these 161 bridges are in my district. However, drivers in my district want to know that when they drive across a bridge elsewhere in the Valley, or elsewhere in Arizona, that it is safe.

--Over the August recess, I had the opportunity to meet with the Arizona Department of Transportation. They took me out to the Loop 202 bridge over 56th street and walked me through their inspection process.

--Mr. Chairman, I know it will come as no surprise when I report to you that the inspection process is both time consuming and expensive. But it is a process that needs to be done.

--I look forward to hearing from you, as well as the rest of our witnesses today.

--I yield back.

Congressman Walz
Statement for the Record
October 23, 2007

RE: Subcommittee on Highways and Transit Hearing on "Highway Bridge Inspections"

Chairman DeFazio and Ranking Member Duncan, I want to thank you for holding this hearing today on such an important topic. First and foremost, it is my honor to represent the state of Minnesota. In the aftermath of the I-35W tragedy, I want to once again commend all those who continue to strive for excellence in rebuilding the bridge and ensuring that safety is of the utmost importance.

I am proud to serve on the Transportation and Infrastructure Committee. In the 110th Congress, the committee has pushed hard to pass legislation governing every aspect of transportation safety. We have passed legislation on rail safety, aviation safety, highway safety and tunnel safety. Swiftly and in a bipartisan manner, the Committee voted to authorize funds for emergency repairs and reconstruction of the Interstate I-35 bridge immediately after the collapse occurred.

While we have worked hard to pass legislation to ensure the safety of all Americans there is still work to be done. The infrastructure in this country is aging requiring more diligence in inspecting and maintaining. First, Congress can and will play a more active role in oversight. We need to take a hard look at the standards that are currently in place. Secondly, I know my fellow Congressman have researched bridges in their respective District to ascertain how many of those are structurally deficient and will take proactive measures to prevent disasters like the one in Minnesota. We cannot and should not tolerate another catastrophe of this magnitude. Mr. Chairman, this hearing is timely and I look forward to the testimony from the panel members.

AFSCME
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Testimony of

Mr. Bart Andersen
Minnesota Department of Transportation
Bridge Inspector

For the

American Federation of State, County and Municipal Employees (AFSCME)

Before the

Subcommittee on Highways and Transit
Committee on Transportation and Infrastructure
U.S. House of Representatives

On

"Structurally Deficient Bridges on the National Highway System"

October 23, 2007

American Federation of State, County and Municipal Employees, AFL-CIO
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Testimony of Mr. Bart Andersen,
Minnesota Department of Transportation Bridge Inspector
for the American Federation of State, County and Municipal Employees
Before the Subcommittee on Highways and Transit Committee on Transportation and Infrastructure, U.S. House of Representatives on
"Structurally Deficient Bridges on the National Highway System"
October 23, 2007

My name is Bart Andersen. I want to thank the Chairman and members of the Subcommittee for inviting me to testify today. I'm a bridge inspector and bridge maintenance worker for the Minnesota Department of Transportation (MnDOT). I am also a member of the American Federation of State, County and Municipal Employees (AFSCME) Minnesota Council 5. My union represents transportation workers across the United States. I'm here today to explain how bridge inspectors are trained and how we conduct inspections. I'll also tell you about a variety of other duties that we're expected to perform on a daily basis to keep motorists safe.

Most importantly, I want you to know that I lack the resources to do my job well and keep motorists safe. In Minnesota, our Department of Transportation is broke and our transportation system is broken. MnDOT lacks the resources and manpower it needs to maintain its transportation infrastructure. It's postponing badly needed construction projects. It's sacrificing rural projects while focusing its attention on projects in metropolitan areas. As a result, driving is now dangerous.

Our two biggest problems are the lack of MnDOT staff and the lack of funds to do bridge work. MnDOT has only 77 inspectors who are responsible for 14,000 bridges. MnDOT policy is to check every bridge at least once every two years. About 30 percent of our bridges are "fractured critical." We're expected to check those fractured bridges once a year. There aren't enough hours in the workday for 77 inspectors to check 14,000 bridges the way we should.

Our inspection work leaves little time for us to do preventative maintenance, which is also a part of our job. Bridge crews typically consist of five to six workers. When two of us are instructed to do inspection, it leaves only three or four workers to do repairs. Before making repairs, those workers spend considerable time setting up traffic control. And they have only a five hour window because their work can't disrupt traffic flow during rush hours.

In addition to inspecting bridges, we have a host of other bridge related responsibilities that must be performed. We patch holes in the concrete on the bridges, and repair the concrete decks and railings. We repair all the wood and concrete noise and retaining walls. We inspect, repair and replace all of the structural steel support for highway signs. We build salt sheds, repair fences on the bridges, install lighting structures and repair culverts. A culvert is a concrete cylinder used to move water

underneath the roadway. This is by no means a complete list of the tasks performed by the 77 bridge inspectors who are currently employed by MnDOT.

Recently, MnDOT hired private inspectors to assist with the backlog and help us meet a December 1st deadline to inspect all bridges. We do not believe that this is the long term solution to the problem. In fact, these private inspectors were hired after the I-35W bridge collapse. If MnDOT had a sufficient number of bridge inspectors prior to this tragedy, there wouldn't have been a need to bring in these private inspectors on an emergency basis.

In addition to insufficient numbers of personnel, we also lack funding to improve the safety of the bridges. Many of our bridges have reached their 20-year replacement age. To compound that need for investment, our bridges built since 1950 are on average four times the size of their predecessors. And the weight they hold is much greater as trucks are now carrying freight that trains used to transport. That means our bridges are under more stress and cost more to replace and preserve.

MnDOT's bridge inspectors are well trained. When employees start a career in bridge maintenance and inspection, they are required to take a one-week course on concepts for bridge inspection. We learn about bridge technology, architecture and key components. Then we attend a two-week training on "Comprehensive Bridge Safety Inspection." This course trains us to identify deficiencies and detect what's causing them. It also provides in-depth training on the Pontis System, which we use to record and document our inspections. Pontis lists key components that correspond with a numerical value that we use to ultimately rate the deficiency of a bridge.

In my opinion, the training we receive prepares us to do a good job of inspecting bridges. We get quality instruction and sufficient information. MnDOT also offers refresher training for team leaders who perform inspections.

Our inspection program treats bridges differently depending upon their condition and design. There are four categories:

- **Routine Annual Inspections** are typically done without specialized equipment. We visually survey the deck, bearings, railings, and any other accessible components.

- **Fractured Critical Inspections** are done with bridge inspection trucks, scaffolds or man lifts. Sometimes they involve more in-depth inspection of critical areas.

- **Underwater Inspections** are done by private contractors, not MnDOT employees.

- **Special Inspections** are unscheduled because they respond to traffic hits, heightened Homeland Security, and other unexpected problems.

In closing, please understand that MnDOT doesn't have enough full-time bridge inspectors to keep motorists safe. It's impossible for 77 inspectors to check 14,000 bridges throughout Minnesota while performing all of the other tasks that are part of the job. Also, we have a backlog of structurally deficient bridges and an increasing problem with steel fatigue in many bridges. But we lack the funding for replacement, repair and preservation.

Looking forward, as Congress considers these issues, I hope you will help us solve the problems of insufficient staffing at state departments of transportation. I hope you will help us with the lack of funding to maintain the transportation infrastructure. The work performed by people like me, who inspect, maintain and repair bridges, is critical to the safety of citizens who use the bridges everyday. As public employees, we are committed to doing everything we can to help protect citizens who use our bridges and highways. But we need your support to do our jobs well and keep motorists safe.

Thank you for listening. I welcome your questions.

Testimony of

Matthew L. Garrett

Director, Oregon Department of Transportation

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HIGHWAY BRIDGE INSPECTIONS

Before the

United States House of Representatives
Committee on Transportation and Infrastructure
Subcommittee on Highways and Transit

October 23, 2007

Oregon Department of Transportation

Introduction
Chairman DeFazio and members of the Committee, my name is Matthew Garrett, and I am the Director of the Oregon Department of Transportation (ODOT). I am pleased to have the opportunity to discuss bridge inspections with you today.

In Oregon ensuring the safety and reliability of the transportation system is our top priority, and like all states we take our responsibility for inspecting bridges very seriously. Thorough bridge inspections, performed at regular intervals by individuals who have the proper training and equipment, are an important part of maintaining a transportation system that is safe and reliable. The information that is gathered from these inspections is used to develop both short term maintenance plans and long term investment strategies and is thus critical to our efforts to preserve the transportation system.

In recent years, Oregon has invested significant resources in preserving the state's bridges. The three Oregon Transportation Investment Acts (OTIA) passed by the Oregon Legislature provided a total of nearly $1.8 billion to repair and replace Oregon's bridges. The OTIA III State Bridge Program alone invested $1.3 billion in repairing cracked bridges on the state highway system. In addition, in SAFETEA-LU this committee provided Oregon a $200 million infusion of funding for the state's bridges that is being used to extend the OTIA III bridge program and meet additional unfunded needs.

The National Bridge Inspection Program
In 1968 Congress passed legislation requiring the Secretary of Transportation to create the National Bridge Inspection Standards (NBIS) and to develop a nationwide bridge inspection program. This action came in response to the collapse of the Silver Bridge in West Virginia in which 46 people died. While the initial NBIS established bridge inspection frequencies, inspector qualifications, and rating procedures, there were issues that were not addressed at that time. The failure of the Mianus River Bridge in Connecticut in 1983 highlighted the need for advanced inspections of certain steel bridges. In 1987, the failure of the Schoharie Creek Bridge in New York as a result of scour (undermining of the foundation material by water) highlighted the need for underwater inspections.

The bridge inspection program is a comprehensive set of procedures that provides a strong basis to monitor the condition of hundreds of thousands of bridges throughout the country in order to protect public safety and preserve the infrastructure that is vital to our economy and quality of life. As with many other important programs, the bridge inspection program is a partnership between the federal government and the states. While the Federal Highway Administration sets the standards and monitors states' implementation, the states actually develop and implement the programs.

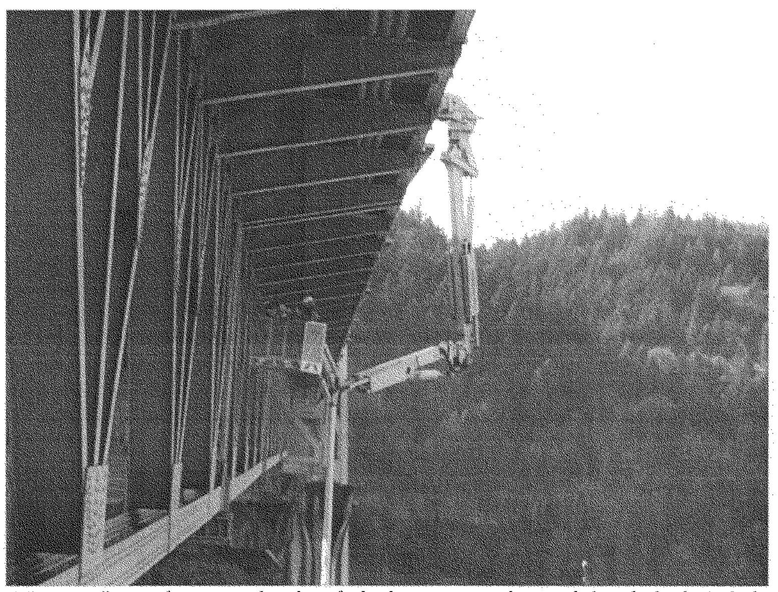
Bridge Inspections in Action
There are three general types of bridge inspections: routine inspections, fracture critical inspections, and underwater inspections. During routine inspections, engineers and trained inspectors look for any signs of distress that could compromise the structural integrity of the bridge. The conditions are documented and monitored, and repairs are recommended if necessary. Inspectors may also order additional investigation if needed, such as taking samples

of the concrete deck for testing. The same process is followed on the above-deck superstructure and the substructure (foundations).

States use a number of inspection techniques. Visual inspections led by engineers are by far the most common and widely used method of inspection. In addition to documenting visible damage, degradation, and distress in structural elements, visual inspection can include quantitative measurements such as loss of steel from corrosion or the size of cracks in concrete. The benefit of visual inspections is that we can collect a large volume of data on the condition of the components of every bridge. The disadvantage is that visual inspections are costly and time consuming.

When necessary, states also use a number of non-destructive testing (NDT) techniques to supplement visual inspections.

- The Magnetic Particle method helps detect cracks in steel.
- Ultrasonic testing identifies cracks in steel that are either too small to be seen, or are beneath the surface of the metal.
- Accoustic Emissions testing measures crack growth in concrete and steel.
- Impact-Echo testing helps find delaminations (internal cracks) inside concrete.
- Resistograph measures the extent of rot or decay inside timber.



A "snooper" crane leans over the edge of a bridge to inspect elements below the bridge's deck.

We select an NDT method depending on the type of material used in the bridge and the type of defect we suspect based on visual inspection and experience. While these techniques all have their virtues, they also have drawbacks. For example, almost all these technologies require specialized training and specialized equipment.
Some other innovative techniques include "health monitoring" of bridges using special gauges and sensors. Oregon is advanced in our use of advanced technology to assess the condition of bridges. We currently have instruments on seven bridges and have installed a device that uses air pressure to measure scour at bridge foundations on one other bridge.

While all bridges receive regular routine inspections, the level and frequency of inspections varies from bridge to bridge. Bridges designed to modern standards and in satisfactory or better condition will receive a routine inspection every two years, which is sufficient for this population of bridges. States can request Federal Highway Administration approval to inspect certain bridges—usually newer structures—at up to a four-year interval. On the other hand, older bridges may receive more frequent routine inspections based on the condition of the bridge, as well as a number of more specialized inspections based on the design. For bridges that have deteriorated the inspection interval is reduced to one year, or in isolated cases, to an even shorter interval. The shorter inspection intervals are kept in place until repairs are made or the bridge is replaced. In Oregon we have 78 state owned bridges and 161 non-state owned bridges, out of a total of 6626 bridges in the state, that are inspected more often than every two years.

In addition to routine inspections, bridge inspectors conduct "fracture critical" inspections of steel bridges every two years, and teams of divers conduct underwater inspections of bridge piers that are in waterways. The frequency of underwater inspections differs from state to state and depends on the bridge's condition, but the federal standards require underwater inspections at least once every five years.

Improvements to the NBIS
The bridge inspection program has been continuously modified and improved as new knowledge, technologies, and standards are incorporated. In fact, the NBIS were significantly updated and strengthened in January 2005. Several important changes were made. The update shortened the inspection interval for fracture-critical bridges to no more than 24 months. Fracture critical bridges are those that could collapse if only one part of the bridge failed. Like some states, Oregon has used a more detailed evaluation of fracture critical bridges to determine a safe inspection frequency for these bridges since 1996.

The update also increased qualifications for bridge inspectors to ensure that quality work is being done by highly skilled and well-trained professionals. Underwater inspectors are now required to have 80 hours of training, and the qualification requirements for Inspection Program Managers and Team Leaders were increased. Non-licensed engineers must now take a ten-day class and have five years experience, with most of that experience taking place directly in field inspection, to become a Team Leader.

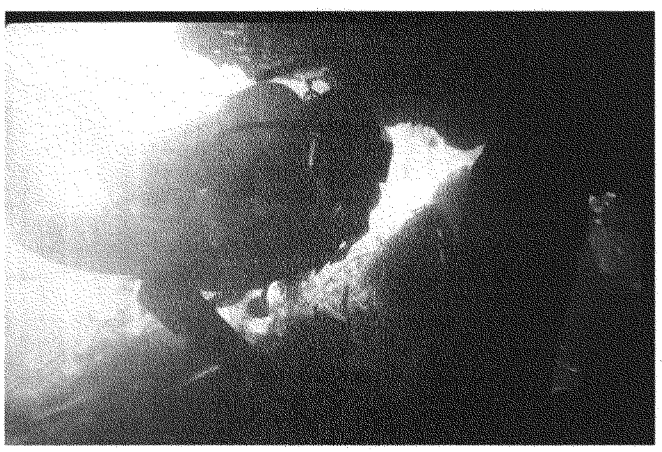
States must also now have a quality control and assurance program in place for their bridge inspection program. The federal standards specify that the program should include periodic field

review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations.

These recent updates to the National Bridge Inspection Standards demonstrate that the Federal Highway Administration and the states are diligent in updating and advancing inspection standards. If the National Transportation Safety Board's inquiry into the cause of the I-35W bridge collapse indicates that the inspection program bears some of the blame, we would welcome additional improvements to the program. However, the states believe this is a very strong program and that we should clearly identify any deficiencies that need to be addressed before imposing additional requirements.

States Exceed Minimum Standards
The NBIS regulations set minimum requirements that all states must meet, but most states exceed the standards. The standards set a very strong foundation and then allow states to address their specific concerns by tailoring their programs. For example, Oregon has elected to inspect all state highway bridges at least six feet long, even though the federal program only requires inspecting bridges with an opening of 20 feet or greater.

Oregon also has a very strong underwater inspection program. As a state that experiences regular heavy rainfall and flooding, we face problems with bridge scour as water erodes material around bridge piers and undermines bridge foundations. Oregon's underwater inspection program is one of the oldest in the country, having been created after floods in 1964 damaged several bridges. ODOT's highly experienced underwater crew performs regular inspections of bridges subject to erosion of the river bed material. Since the inception of the underwater inspection program the dive team has identified several bridges with considerable damage to the



A member of ODOT's underwater dive team inspects a bridge's substructure.

foundation from scour. In addition, ODOT conducts underwater "sounding" of streambeds to monitor or confirm that scour is occurring on some of our bridges with scour history. When scour issues are identified, they are addressed and the bridge foundations are stabilized.

Like other states, Oregon has a robust and detailed quality assurance program to ensure that bridge inspections are accurate and complete. We adopted this program in 1994, and it far exceeds the minimum federal standards. Each year, a portion of each inspector's work is reviewed by a team that includes both headquarters personnel and other inspectors. The result has been greater consistency among inspectors working in different parts of the state. In addition to the in-house quality assurance effort, the Federal Highway Administration also takes part in reviewing individual bridge inspections and the bridge inspection process, including documentation.

ODOT has implemented several more stringent requirements for inspector qualifications. In order to become a certified bridge inspection team leader in the State of Oregon, the applicant must pass a field proficiency test to assure that they can perform the work in a competent manner. The test is an actual field inspection, which is then reviewed on site by a team of very experienced engineers to check for compliance with established standards with a very narrow margin of error. ODOT has also developed a unique performance measure that actually measures whether an inspection is acceptable or not and whether the inspector is producing an acceptable level of service.

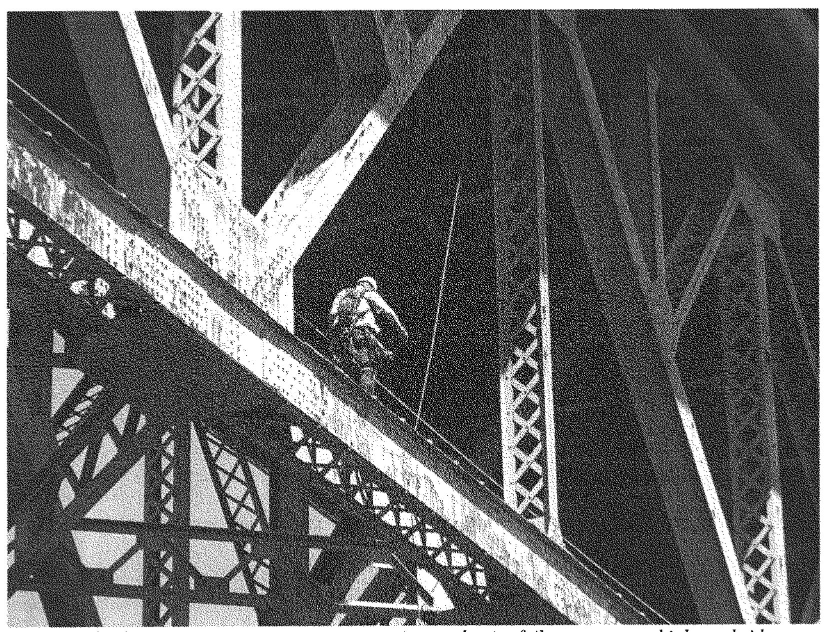
Bridge inspection requires significant resources. Federal regulations give states responsibility for the inspection of all state, local and other (non-federal) public agency bridges. In addition to ODOT's five in-house Region Bridge Inspectors and two assistant bridge inspectors, ODOT uses consultants for in-depth inspection of several major bridges and also for all local agency bridge inspections. ODOT's total cost for bridge inspections is approximately $3.7 million per year. If additional inspections are required under a revamped bridge inspection program, this cost will rise, which will reduce the funding available to repair and reconstruct bridges.

Bridge Inspection Data Drives Investments in Maintenance and Preservation
Bridge inspection data is the primary information that is stored in our bridge management system. This information is used to program bridge maintenance, rehabilitation, and replacements. Immediate concerns that are uncovered by inspections can be addressed through a combination of temporary closures, emergency repairs, and load restrictions. Bridges that are in poor condition are included in the "Critical Follow-up List." These bridges get special attention to address needs so that they can be removed from this list. For example, this summer an inspector identified deteriorated timber piles supporting a bridge that is on the National Highway System. After this discovery we inspected the bridge monthly and restricted loads restricted until repairs were completed in early October.

I would like to provide you a larger example of how the bridge inspection program helps identify and address problems. When our bridge inspectors first noted structural cracks in some of Oregon's reinforced concrete deck girder bridges that were constructed during the 1950s, we used the Bridge Inventory database to identify all bridges of this type. We then used access equipment to get an "arms length" inspection of the cracks so that they could be fully

documented and we could monitor any further changes in condition. Inspections determined that the cracks were extensive, occurring in hundreds of bridges in the state. The problem would significantly impact the movement of freight because many bridges on the Interstate and other key freight routes would require weight limits if they were not repaired or replaced. This would require lengthy detours for trucks that would impose huge additional costs on the movement of freight. As a result, the economic impacts of these cracked bridges would be huge; a study ODOT prepared determined that the state's deteriorating bridges could cost the state's economy 88,000 jobs and $123 billion in lost productivity over the next two decades if left unaddressed. In order to determine which bridges would require weight limits and which needed to be repaired or replaced, we worked with Oregon State University to build full scale bridge components with 1950s details. We then tested these components to determine the loads that would cause them to fail.

These bridge inspections helped identify a major problem on our state highway system that prompted the Oregon Legislature to invest over a billion dollars in our state's bridges. The research Oregon State University conducted helped guide our investment under the OTIA III State Bridge Program. By better understanding the loads our bridges could bear we were able to repair rather than replace many bridges and take some off the critical list entirely.



An ODOT bridge inspector examines rust, corrosion, and paint failure on a state highway bridge near downtown Portland.

The OTIA III State Bridge Program and the bridge program funded through our Statewide Transportation Improvement Program (STIP) will significantly reduce the number of structurally deficient bridges on the National Highway System (NHS) in Oregon. Oregon has 206 structurally deficient bridges, and 99 of those are on the National Highway System. By 2011, state and federal investments in bridges will have eliminated 67 of these structurally deficient bridges on the NHS.

However, OTIA III addressed only a portion of one problem—cracked bridges on freight routes—at one point in time and left significant bridge needs unmet. We estimate that in Oregon over the next 25 years the gap between available bridge funding and our need for bridge repairs and replacement will reach $3.2 billion. Even with the OTIA III funding, Oregon will still have many structurally deficient bridges, primarily bridges that are not on the NHS, which may remain in service for many years. The deterioration of these older bridges will not be addressed with our current level of funding. These bridges already require a greater level of inspection effort than modern bridges that are in satisfactory condition. As the average age of Oregon's bridges—already at 50 years— continues to rise, even more resources will need to be dedicated to bridge inspection, maintenance, and management.

Conclusion
In the 40 years since the National Bridge Inspection Standards were first developed, the inspection program has matured to become a strong and comprehensive program. Bridge inspections performed to the federal standards have identified several Oregon bridges with structural and scour issues that were repaired with little fanfare or impact to the public. Oregon's inspections of steel deck truss bridges that followed the Minneapolis bridge collapse confirmed the quality of the existing inspections, because no new deficiencies were noted. The National Bridge Inspection Standards have demonstrated the flexibility to change as new concerns are identified. Any changes to the National Bridge Inspection Standards resulting from the Minneapolis bridge collapse should build on the excellent work of the past 40 years and ensure that states continue to have the flexibility to focus their programs on their particular needs.

Responses to Additional Questions for the Record
Subcommittee on Highways and Transit Hearing on Bridge Inspection Standards
Provided by Matthew Garrett
Director, Oregon Department of Transportation

***Q1**: Improved inspection techniques and frequencies could substantially lower the risk of another catastrophic bridge failure that takes many innocent lives. What is your state doing to upgrade the reliability and timeliness of identifying bridge deficiencies so that problems are identified sooner and repairs on these structures at lower cost?*

We believe reliability of the data is embodied in the Quality Control and Quality Assurance Measures that have been integrated into the bridge inspection program, which includes all of the following:

- ODOT takes the accuracy and consistency of the bridge inspection data very seriously because it is considered to be central to our entire bridge program. In order to achieve a high level of accuracy and consistency, we need to assure that all bridge inspectors are well qualified to perform the assigned work. As a result, we do not automatically accept the bridge inspection team leader certifications from other states. In order to perform this type of work in the State of Oregon each bridge inspection team leader is required to satisfactorily complete an ODOT administered bridge inspection proficiency test in the field.
- Due to the large number of structures that are assigned to each inspector, it's imperative that each assigned inspector budget their time and resources wisely, because we believe a rushed bridge inspection will most likely result in missed bridge elements and inaccurate condition assessment rating information. The quality of the bridge inspection data is closely measured during our very proactive Quality Assurance review procedures, which includes independent field verification of a sampling of the inspections. The thought is that if the bridge inspector knows that someone is going to be checking their work, they're going to take the time necessary to assure that every bridge inspection report is thorough, accurate and complete.
- Even though the Code of Regulations allow a much longer data entry time frame, ODOT'S bridge inspection data entry process and the dissemination of bridge maintenance / repair recommendations have been totally automated by utilizing the internet and intranet web page applications. From noting a deficiency to notification of a need can be as short as a few minutes to as long as week, depending on the criticality of the deficiency.
- ODOT promotes the use of full-time inspectors that are assigned to inspect the same structures. Given the opportunity, it is thought that the inspector will take ownership of those structures and as a result they are better equipped to measure the condition of the structure and develop sufficient foresight to anticipate deficiencies before they occur.
- ODOT requires the person that found or noted a deficiency to be the same person to enter the condition assessment information into the database, thereby minimizing transcription errors.

Q2: Can you explain the steps you have taken to ensure the Oregon's inspection program provides proper inspection training, procedures, techniques and technology to mitigate human error and subjective assessments?

Training: All bridge inspection team leader certifications have a 5 year expiration date. In order to renew their certification in the State of Oregon, ODOT requires each bridge inspection team leader to complete 50 hours of continuing bridge inspection education over a 5 year period. The bridge inspection education must meet the criteria specified in the NBIS.

Procedures, techniques and technology: ODOT publishes our own Element Coding Guide which contains detailed descriptions of the bridge inspection business rules. ODOT also publishes a more detailed Bridge Inspection Manual, which clearly lays out processes and procedures.

Mitigate human error: ODOT has instituted a very proactive Quality Assurance (QA) Review process which is performed in the field on completed bridge inspection work. Following each QA review findings are shared with others throughout the bridge inspection community, and needed changes or clarifications are incorporated into the field manual.

Subjective Assessments: ODOT has addressed many of these subjective assessments by providing very distinct and measurable definitions, thereby mitigating the use of subjective terms where possible.

Q3: What types of advanced technologies does ODOT employ to aide in its bridge inspections?

Oregon uses ultrasonic testing (sound waves that bounce off defects inside the material) to identify cracks that are either too small to be seen, or are beneath the surface of the metal. We use ultrasonic testing to ensure that our Pin and Hanger assemblies do not have cracks, without having to close the bridge and take apart the entire assembly. For our moveable bridges, we have sensors that measure the torque that is applied to gears, tilting of foundations (due to tides or bridge opening), and the position of the moveable span. On some bridges we measure the humidity and air temperature, since materials expand and contract with changes in temperature. We have used strain gauges (resisters that change the resistance value when pushed or pulled) to compare the calculated loads on a bridge with the actual stresses. By knowing the actual loads that are associated with a given truck, we can make better decisions regarding the repair and replacement of bridges. These technologies are commonly used throughout the United States.

Oregon and Florida are the leaders in using cathodic protection (a small voltage electrical current) to slow the rate of corrosion for reinforced concrete bridges located on the coastline. The systems we have in place have a layer of zinc with a small electrical current flowing through it. We have sensors to measure the electrical current to ensure the operation of the system. We have also used acoustic emissions (high frequency sound waves) to monitor deterioration in both steel and concrete bridges. In addition, we have placed sensors across cracks in concrete bridges to measure permanent crack growth, and to see how crack size is affected by daily and seasonal temperature changes.

The most important and effective method of bridge inspection is having a properly trained inspector performing visual inspection. This method is used to assess the general condition of the entire structure. When the inspector identifies an area of concern then it may be appropriate to follow-up with more specific inspections that involve both mature and advanced technologies to better characterize the severity of the defect.

Under such circumstances ODOT typically uses:

- magnetic particle testing (a powerful magnet that aligns small magnetic dust particles with cracks in order to identify non-visible cracks),
- ultrasonic testing (sound waves that bounce off defects inside the material),
- strain gauges (resisters that change the resistance value when pushed or pulled),
- vibration testing (measures vibrations of cable to determine the load),
- radiography (x-rays that expose a film negative to show cracks and voids),
- acoustic emissions testing (measuring high frequency sound waves to see if interior cracks are growing),
- thermal imaging (infrared photography that shows cracks).

These inspection and testing methods can be divided into three main categories: 1) Surface inspections, 2) Volume inspections and 3) Performance inspections.

Surface Inspections: Surface inspections are the most common and use technologies such as:

- Magnetic particle (a powerful magnet that aligns small magnetic dust with the crack),
- Dye Penetrant (liquid dye that penetrates into surface cracks to highlight the cracks) and
- Eddy current (a sensor that develops a fluctuating magnetic field and displays "breaks" in the field as lines on a video screen) to highlight or magnify surface defects.

They can be used to discriminate between benign fabrication defects and active fatigue cracks.

Volume Inspections: Inspection technologies that can "see" below the surface into the interior of a material are used to locate and identify subsurface defects or defects that are not accessible to visual or other surface inspection methods. The most common forms are ultrasonic testing, impact echo testing (measuring the time it takes sounds waves to travel through material to see if there are cracks or voids inside), and thermal imaging.

Performance Inspections: Performance testing involves installing transducers that yield an electrical signal that is proportional to a physical response such as resistance and vibrating wire strain gauges (which measure the pulling load in a fine wire that vibrates faster or slower depending on how hard it is pushed or pulled), displacement and tilt meters (which measure small changes in electrical resistance to accurately measure and record the long term rotational movement), accelerometers (measures the energy it takes to move a piece of steel on a bridge when traffic is moving on the bridge), and acoustic emissions sensors (measuring high frequency sound waves to see if interior cracks are growing). This approach requires the structure to be loaded and unloaded during the test. Data from these measurements is often compared to analytic models of the bridge structure to determine if it is performing as expected.

Utilizing the defect characterization from the surface and volume inspection, in conjunction with the performance testing data, provides a fitness-for-purpose evaluation of the structure and can be developed to assess the remaining service life of the structure.

Q4: Specifically, could you elaborate on the instruments that ODOT has installed on the seven bridges you mention in your testimony?

Isthmus Slough drawbridge in Coos Bay, Oregon is the first structure to receive a structural health monitoring (SHM) system which was installed in 2000. There were some serious concerns with the stability of the foundation which lead to installing several vibrating wire tilt meters, which accurately measure and record the long term rotational movement of the main bascule piers. The output from these transducers is collected by an onsite computer that collects the data and transfers it to a main server in Salem. The long term data has shown that the repairs made to the structure in 2001 have stabilized the foundation.

The **Luckiamute river bridge** (near Monmouth) was the next SHM system installed in 2004. This system was designed and installed in-house as a test bed for applying SHM to Oregon's problem with cracked reinforced concrete deck girders (RCDG) in conjunction with research conducted by Oregon State University on this issue. Instead of sending a bridge inspector to the bridge every week to observe diagonal tension cracks in the girders, we developed and installed a system to measure crack widths, temperature and humidity. The sensors used to measure and record crack width were potentiometers (measuring voltage changes to see if surface cracks are growing) and Linear Variable Displacement Transducers (LVDT) (measuring electrical resistance to see if surface cracks are growing). Temperatures are measured with thermocouples (measuring electrical resistance in very fine wires to see if the temperature is changing). Data is collected and recorded by an onsite computer and transferred to a central server in Salem. Our crack width data is no longer subjective and we have a continuous record of crack widths and their response to environmental changes. Acoustic emissions testing was also employed on this structure to be correlated with laboratory data taken during the OSU beam testing project.

The **Banzer bridge** near Mist was the next bridge to receive a SHM system in 2005. This bridge was chosen due to the very large diagonal tension cracks in the RCDG. Load rating indicated adequate capacity. It was suspected the large cracks were the result of illegal over loads. A SHM system was installed to measure crack widths, rebar strain, temperature and humidity. Crack widths are measured with potentiometers and rebar strains are measured with resistance strain gauges with the data being collected on site by a computer and transferred to a central server in Salem.

Interstate 5 SB over the Columbia River bridge had a SHM system installed in 2006. This system is focused on the performance of the lift span and counterweights, which have been very problematic since the 1980's. This system measures the tilt angles of the counterweight and lift span; the gaps between the counterweights and guide rails; drive motor torque; span position; and temperature and rainfall accumulation. The tilt meters use the vibrating wire technology. The rail gaps are measured with lasers and the temperatures are measured with thermocouples. The span position and drive torque is measured using a digital encoder (measuring electrical

resistance changes to indicate changes in position relative to a fixed point) and variable frequency drive system (measuring the change in frequency of vibration to determine the speed of a rotating member) respectively. The data collected from this system has finally allowed us to better understand and begin to remedy the alignment problems with the lift span and counterweights.

Umpqua River Bridge near Reedsport had a SHM system installed in 2007 to monitor the performance of the recently repaired pivot bearing that supports this 420 foot swing span. In 2006 the bearing froze up due to inadequate lubrication. ODOT removed and repaired the bearing during the summer of 2006. This system measures drive torque, span position, wind speed and direction to assess the performance of the rehabilitated bearing. The drive torque is measured with piezoelectric hydraulic pressure transducers (measuring fluid pressure in pipes to determine the power of an electric motor) and the span position is measured with a digital encoder. It will provide early notice if the bearing starts to degrade and allow for a timely repair.

Cummings Creek bridge has a SHM system installed that monitors the performance of the cathodic protection system allowing corrosion engineers to finely tune the impressed current which will result in maximum efficiency of the CP system. Voltage reference cells are used to measure the potential between the rebar and the zinc coating on the concrete. Installation of the SHM system was completed in 2007 which transfers data from an onsite computer to a central server in Salem.

The Fremont bridge on I-405 is currently under contract to have a SHM system installed in the tie girders. This is one of Oregon's most important and complex bridges. Fatigue cracking has been identified and repaired in this structure. Future cracking is expected to occur, so ODOT has a long term maintenance plan to keep this structure healthy and safe. The cracking is caused by thermal loads as opposed to live loads so the rate of crack growth is fairly slow. This system monitors and records strain, temperature, wind speed and direction. The strain gauges are based on vibrating wire technology and the temperatures are measured with thermocouples. The data is collected by four onsite computers and transferred to a central server in Salem.

I205 southbound to I5 southbound over crossing is currently under contract to have a SHM system installed in the trapezoidal box girders and cross beams. Very significant fatigue cracks were discovered at the connections between the crossbeams and box girders back in 1997. All connections were retrofitted by 2005. This system is very similar to the Fremont system in that it measures and records strains, distortion induced displacement and temperature. Because the cracking may be driven by traffic loads as well as thermal loads, resistance strain gauges are used to measure strain as they have a faster response time. Temperatures are measured with thermocouples. Displacements are measured with LVDT's. The data is collected by four onsite computers and transferred to a central server in Salem.

Spencer Creek bridge is currently under a replacement contract. The new structure will use a special foundation that requires performance monitoring both during and after construction. Performance parameters such as arch thrust, soil pore pressure and pier tilt will be measured and recorded for many years after the construction is completed. Pressure is measured with

piezoelectric transducers and pier tilt is measured with vibrating wire technology. The data will be collected by two onsite computers and transferred to a central server in Salem.

Q5: *How did the state select those technologies?*

With the exception of acoustic emissions testing all of the technologies being employed are well developed. We select each type of technology based on the specific concern or need on each bridge, and the ability of the technology to provide relevant data. Each transducer type is selected based on performance parameters such as stability; frequency response; signal output level; and environmental robustness. The basic technology for each transducer type has been in use for many decades (with the exception of laser distance measurements) and the biggest improvements seen in the last decade are cost and compactness of size. In the past, hardware costs were the most significant cost of installing such systems. Now the installation costs typically match or exceed the hardware costs. Hardware costs will likely continue to decline. Total system costs range from \$40,000 to \$198,000 for the bridges discussed above with hardware comprising 30% to 50% of the total.

Q6: *What is the state's process for prioritizing its inspection activities and targeting its investments?*

The frequency of bridge inspections is established by federal regulation and is met by the department on a regularly scheduled basis. The state does prioritize inspection activities for reduced frequency inspections based on an engineering judgment of the relative seriousness of defects or damage. Emergency inspections are conducted as the need arises. Reduced frequency routine inspections are done when serious structural defects are suspected of changing before the regulatory two year interval. The process for targeting investments is described below in the answer to Q10.

Q7a: *We just received information in response to a written question from the September 5th hearing about an informal survey AASHTO conducted of its members. The survey found that of the 40 states that responded, only 24 of the states exceed National Bridge Inspection Standards. So many states do exceed the Federal minimum. Does it raise concerns with you that 16 states in this informal survey do not exceed the Federal standard?*

We believe states have sufficient knowledge of their infrastructure, traffic demands, and environmental conditions to assess whether or not it is necessary to exceed Federal standards. We are one state that does exceed Federal standards in some areas, but not in others. We rely on other states to make those decisions and believe they can properly assess whether exceeding any Federal standards is necessary for their specific conditions or infrastructure types.

Q7b: *Should non-redundant, structurally deficient bridge only receive a routine visual inspection once every two years?*

ODOT operates with the philosophy that each bridge must be inspected as thoroughly as necessary to clearly establish its condition and to insure its continued safe operation. The question does not specify the bridge material type. If the bridge material is steel, the question clearly addresses bridges that are Fracture Critical and could require the initiation of various non-destructive evaluation methods depending on the structural detail. If the bridge is concrete or timber, a visual inspection that utilizes routine inspection techniques every two years is probably adequate.

***Q8**: You note that Oregon has poured billions of dollars into bridge inspection and repair, but that the state still faces a resource crunch with regard to bridges. How do you suggest that states and the federal government work to increase the funding available for bridges?*

Due to the age and growing travel and freight demands on the transportation system, a significantly increased long term and sustainable investment to maintain and expand the system is needed. Any one-time investment in bridges or any other part of the transportation system may be able to significantly improve the health of the system in the short term but will not address the long term challenges. For example, Oregon's investment of $1.3 billion in state highway bridges under the OTIA III program will significantly improve the condition of the state's bridges in the short term. However, this 10-year program will not provide continued investment into the future, and after the OTIA III bridge program's completion the health of the state's bridges will decline significantly unless additional investments are made. To adequately address our infrastructure challenges, we need a strong commitment from all levels of government—federal, state, and local—to invest the resources that will be needed to preserve our existing infrastructure and expand it to meet the need for increased capacity. Any increased federal investment should be sustainable and provided with sufficient flexibility to allow states to manage their system to meet local needs.

***Q9**: Can you talk about the states effort to target its limited resources on inspection, rehabilitation and reconstruction of the most vulnerable bridges?*

As the condition of a given bridge reaches a pre-defined state of disrepair, the inspection frequency is shortened accordingly. Also ODOT has identified a number of other in-depth types of inspections over and above those specified in the NBIS. The project selection process, described below in Q10, identifies bridge needs in twelve separate categories, including condition of bridge components (subject to deterioration); functional (deviation from current standards); and event-driven needs (such as scour). There is an in-depth review of each bridge that has needs identified through the bridge management system. Bridges with elements that have accelerated deterioration rates, such as timber columns, are given special consideration in the selection process. Bridges with details that are not desirable, such as steel bridges with welded cover plates, are also given special consideration in the selection process. By incrementally reducing the number of bridges with materials or details that place them at higher risk, the overall reliability of the entire system is increased.

***Q10**: Can you provide the committee with information on the state's bridge management system and how you utilize this system to manage your bridge program?*

Since 1993, Oregon has maintained bridge inspection condition information in Pontis, bridge management software subscribed to by 39 states. Since 1999, Oregon's project selection method has integrated inspection data from Pontis with other bridge condition data, specifically non-deterioration based needs, including, as examples: seismic, scour and functional deficiencies. The linked data collections are used to identify bridge needs in twelve categories. Data primarily from Pontis is used to select bridges in the substructure, superstructure, and deck condition categories. Data outside of Pontis is used to select problem bridges in the seismic, scour, bridge rail, deck width, load capacity, vertical clearance, paint, coastal bridge (cathodic protection), and movable bridge categories.

Outside of its use as a repository for inspection data, Oregon's efforts to implement Pontis through development of the deterioration and cost models was derailed for a period of about five years due to reaction to shear cracking in reinforced concrete deck girder bridges and a major reorganization. As a result of this period, greater emphasis has been given to load capacity on freight routes and route continuity, moving away from a strictly "worst first" project selection process. Increases in the costs of traffic mobility and project staging have also influenced the popularity of targeting route segments for repair and replacement projects.

Beginning in 2006, Oregon resumed efforts to implement Pontis and has now completed the initial development of deterioration and cost models. Oregon continues to use a refined version of its Twelve Category Bridge Management System (BMS) in the project selection process.

Statement of
King W. Gee, Associate Administrator for Infrastructure
And
Gary Henderson, Director, Office of Infrastructure Research and Development
Federal Highway Administration
United States Department of Transportation
Hearing on Highway Bridge Inspections
Before the
Committee on Transportation and Infrastructure
Subcommittee on Highways and Transit
United States House of Representatives
October 23, 2007

Mr. Chairman and Members, thank you for the opportunity to testify today on the Federal Highway Administration's (FHWA) bridge inspection program, and FHWA research work on bridge technology and inspections. This is a very important hearing topic in the wake of the tragic collapse of the Interstate 35 West (I-35W) bridge over the Mississippi River in Minneapolis, Minnesota.

We do not yet know why the I-35W bridge collapsed, and the Department of Transportation is working closely with the National Transportation Safety Board (NTSB) as it conducts a thorough investigation, including a structural analysis of the bridge, to determine the cause or causes. Within days of the collapse, development of a computer model based upon the original design drawings for the bridge began at FHWA's Turner Fairbank Highway Research Center (TFHRC) in McLean, Virginia. Since then, the model has been improved to include the actual condition of the bridge, actual loads on it, and other factors that need to be considered in the assessment of the bridge. This model can perform simulations, to determine the effect on the bridge, by removing or weakening certain elements to recreate, virtually, the actual condition of the bridge just prior to and during the bridge's collapse. By finding elements that, if weakened or removed, result in a bridge failure similar to the actual bridge collapse, the investigators' work is considerably shortened.

In addition, our forensic experts continue to provide onsite assistance to the NTSB and the Minnesota Department of Transportation during recovery of the key components of the bridge that are required to complete the forensic investigation. Several components of the bridge have now been shipped to the TFHRC to continue the forensic investigation by conducting material characterization studies; other components will be shipped shortly. We need to fully understand what happened so we can take every possible step to ensure that such a tragedy does not happen again.

While examination of the physical members of the bridge being recovered from the site provides the best evidence of why the bridge collapsed, the analytical model allows the evaluation of multiple scenarios which can then be validated against the physical forensic evidence. We are committed to helping NTSB complete its work as quickly as possible, but the process is expected to take a number of months.

As we await the NTSB findings, the Department is taking every step possible to reassure the public that America's infrastructure is safe. The Department has issued two advisories to States in response to what has been learned so far, asking that States re-inspect their steel deck truss bridges and that they be mindful of the added weight construction projects may add on bridges. On August 2, the day after the collapse, Secretary of Transportation Mary Peters requested the Department of Transportation's Inspector General to conduct a rigorous assessment of the Federal-aid bridge program and the National Bridge Inspection Standards (NBIS), and this assessment is underway.

National Bridge Inspection Program

Federal, State, and local transportation agencies consider the inspection of our nearly 600,000 bridges to be of vital importance and invest significant funds in bridge inspection activities each year. We strive to ensure that the quality of our bridge inspection program is maintained at the highest level and that our funds are utilized as effectively as possible.

The National bridge inspection program was created in response to the collapse, in 1967, of the Silver Bridge over the Ohio River between West Virginia and Ohio, which killed 46 people. At the time of that collapse, the exact number of highway bridges in the United States was unknown, and there was no systematic bridge inspection program to monitor the condition of existing bridges. In the Federal-aid Highway Act of 1968, Congress directed the Secretary of Transportation in cooperation with State highway officials to establish: (1) NBIS for the proper safety inspection of bridges, and (2) a program to train employees involved in bridge inspection to carry out the program. As a result, the NBIS regulation was developed, a bridge inspector's training manual was prepared, and a comprehensive training course, based on the manual, was developed to provide specialized training. To address varying needs and circumstances, State and local standards are often even more restrictive than the national standards.

The NBIS require safety inspections at least once every 24 months for highway bridges that exceed 20 feet in total length located on public roads. Many bridges are inspected more frequently. However, with the express approval by FHWA of State-specific policies and criteria, some bridges can be inspected at intervals greater than 24 months. New or newly reconstructed bridges, for example, may qualify for less frequent inspections. Approximately 83 percent of bridges are inspected once every 24 months, 12 percent are inspected annually, and 5 percent are inspected on a 48 month cycle.

The State transportation department (State DOT) must inspect, or cause to be inspected, all highway bridges on public roads that are fully or partially located within the State's boundaries, except for bridges owned by Federal agencies. Federal agencies perform inspections through other processes beyond those performed by the State DOTs. Privately owned bridges, including commercial railroad bridges and some international crossings, are not legally mandated to adhere to the NBIS requirements; however, many privately owned bridges on public roads are being inspected in accordance with the

NBIS. States may use their Highway Bridge Program funds for bridge inspection activities.

For bridges subject to NBIS requirements, information is collected on bridge composition and conditions and reported to FHWA, where the data is maintained in the National Bridge Inventory (NBI) database. The NBI is essentially a database of bridge information that is "frozen" at a given point in time. This information forms the basis of, and provides the mechanism for, the determination of the formula factor used to apportion Highway Bridge Program funds to the States. A sufficiency rating (SR) is calculated based on the NBI data items on structural condition, functional obsolescence, and essentiality for public use. The SR is then used programmatically to determine eligibility for rehabilitation or replacement of the structure using Highway Bridge Program funds. Ratings of bridge components such as the deck, superstructure, and substructure assist States in prioritizing their bridge investments.

Bridge inspection techniques and technologies have been continuously evolving since the NBIS were established over 30 years ago and the NBIS regulation has been updated several times, as Congress has revised the inspection program and its companion program, the Highway Bridge Program (formerly Highway Bridge Replacement and Rehabilitation Program). The most recent NBIS revision took effect in January 2005. The bridge inspector's reference manual has been updated as well, and we have developed, through our National Highway Institute (NHI), an array of bridge inspection training courses.

There are five basic types of bridge inspections--initial, routine, in-depth, damage, and special. The first inspection to be completed on a bridge is the "initial" inspection. The purpose of this inspection is to provide all the structure inventory and appraisal data, to establish baseline structural conditions, and to identify and list any existing problems or any locations in the structure that may have potential problems. The "routine" inspection is the most common type of inspection performed and is generally required every two years. The purpose of "routine" inspections is to determine the physical and functional condition of a bridge on a regularly scheduled basis. An "in-depth" inspection is a close-up, hands-on inspection of one or more members above or below the water level to identify potential deficiencies not readily detectable using routine inspection procedures. A "damage" inspection is an emergency inspection conducted to assess structural damage immediately following an accident or resulting from unanticipated environmental factors or human actions. Finally, a "special" inspection is used to monitor, on a regular basis, a known or suspected deficiency.

Visual inspection is the primary method used to perform routine bridge inspections, and tools for cleaning, probing, sounding, and measuring, and visual aids are typically used. On occasion, destructive tests are conducted to evaluate specific areas or materials of concern, or to help identify appropriate rehabilitative work. Type, location, accessibility, and condition of a bridge, as well as type of inspection, are some of the factors that determine what methods of inspection practices are used. When problems are

detected, or during the inspection of critical areas, nondestructive evaluation (NDE) methods and other advanced technologies are employed.

Commonly used methods for evaluating concrete elements during "routine" inspections include mechanical sounding to identify areas of delamination (the separation of a layer of concrete from the reinforcing steel in the concrete member) and other forms of concrete degradation. Similarly, for the "routine" inspection of steel members, methods include cleaning and scraping, and the use of dye penetrant and magnetic particle testing to identify cracking and areas of significant corrosion.

State-of-the-art methods utilized during "in-depth," "damage," and "special" inspections include impact echo, infrared thermography, ground penetrating radar, and strain gauges for concrete structures and elements, and ultrasonic, eddy current, radiography, acoustic emissions, strain gauges, and x-ray technology for steel structures and elements.

There are numerous other technologies under development that have the potential to substantially advance the practices used for bridge inspection. Some of these technologies are also being developed or are in limited use by other industries, such as the aerospace and nuclear power industries. But, there is no one-size-fits-all approach in the use of nondestructive evaluations and testing; each technology is designed for a specific purpose and function. Although these developing technologies have the potential to augment and advance bridge inspection practice, the challenge is to find a way to make them efficient, effective, and practical for field use. FHWA, industry, academia, the Transportation Research Board (TRB), and State DOTs continue to investigate and improve the practicality of many of these technologies. As a result of these efforts, a number of systems have recently become available that can assist an inspector in the identification and quantification of such things as reinforced concrete deterioration, steel tendon distress, and the displacement or rotation of critical members in a bridge.

There are also a number of monitoring systems that can be used to provide real time data and alert the bridge owner to such things as failure of load carrying members, excessive rotation or displacement of an element, overload in a member, growth of a crack, or scour around a bridge pier. The type of information provided by these systems is either very specific and provides detailed information on isolated areas or members of the bridge, or rather generic and provides general bridge behavior information. The most practical of these systems are being used by owners following an "in-depth" or "special" inspection, to monitor the performance of the element or the bridge, when some specific concern has been raised but the concern is not considered to be a short-term safety hazard. However, the effectiveness and costs associated with monitoring systems must be weighed against the benefits gained. Like any emerging technology, changes and updates in monitoring systems can become a big challenge to maintain economically over the long haul. Today, bridges are being built to last 75 to 100 years and installing any new monitoring systems and expecting them to be durable and serviceable for such a long period has never been done before. Monitoring systems that are available today require routine maintenance and repair and continuous assessment to ensure that they are

working correctly. In addition, they do not eliminate the need for regular visual inspections. In many circumstances, it is more effective to increase the inspection frequency, repair or retrofit areas of concern, or replace the structure.

Since 1994, the percentage of the Nation's bridges that are classified as "structurally deficient" has declined from 18.7% to 12.1%. The term "structurally deficient" is a technical engineering term used to classify bridges according to serviceability and essentiality for public use. Bridges are considered "structurally deficient" if significant load-carrying elements are found to be in poor or worse condition due to deterioration or damage, or the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing intolerable traffic interruptions. The fact that a bridge is classified as "structurally deficient" does not mean that it is unsafe for use by the public. Classification as "structurally deficient" may mean that the bridge is not capable of safely carrying its originally designed load, but is safe to remain in public use with a lower capacity restriction. If a bridge is unsafe, it is closed to public use.

The infrastructure quality numbers for bridges should, and can, be improved, but it is inaccurate to conclude that the Nation's transportation infrastructure is unsafe. We have quality control systems that provide surveillance over the design and construction of bridges. We have quality control systems that oversee the operations and use of our bridges. And we have quality control over inspections of bridges to keep track of the attention that a bridge will require to stay in safe operation. These systems have been developed over the course of many decades and are the products of the best professional judgment of many experts. We will ensure that any findings and lessons that come out of the investigation into the I-35W bridge collapse are quickly learned and appropriate corrective actions are institutionalized to prevent any future occurrence.

Bridge Research and Technology Programs

The current FHWA bridge research program is focused on three areas: (1) the "Bridge of the Future," (2) effective stewardship and management of the existing bridge infrastructure in the United States, and (3) assuring a high level of safety, security, and reliability for both new and existing highway bridges and other highway structures.

The "Bridge of the Future" is intended to be a bridge that can last for 100 years or more and require minimal maintenance and repair, while being adaptable to changing conditions such as increasing loads or traffic volumes. FHWA's bridge research and technology (R&T) programs seek to improve the long-term performance of our Nation's highway bridges--both those exposed to normal everyday traffic and use and those exposed to the damaging effects of extreme natural and man-made hazards--in an effective yet economical way.

In the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Congress authorized and funded research in 5 program areas: long-term bridge performance, innovative bridge delivery, high performance and

innovative materials, nondestructive inspection technology, and seismic research. The specific programs authorized by SAFETEA-LU are summarized in the following:

Long-term Bridge Performance

Long-Term Bridge Performance Program (LTBPP) – The LTBPP has been designed as a 20-year effort that will include detailed inspections and periodic evaluations and testing on a representative sample of bridges throughout the United States in order to monitor and measure their performance over an extended period of time. The program will collect actual performance data on deterioration, corrosion, or other types of degradation; structural impacts from overloads; and the effectiveness of various maintenance and improvement strategies typically used to repair or rehabilitate bridges. The resulting LTBPP database will provide high quality, quantitative performance data for highway bridges that will support improved designs, improved predictive models, and better bridge management systems. The program has been underway for approximately one year.

Innovative Bridge Delivery

Innovative Bridge Research and Deployment (IBRD) Program – The IBRD program encourages highway agencies to more rapidly accept the use of new and innovative materials and technologies or practices in highway structure construction by promoting, demonstrating, evaluating, and documenting the application of innovative designs, materials, and construction methods in the construction, repair, and rehabilitation of bridges and other structures. This will increase safety and durability and reduce construction time, traffic congestion, maintenance costs, and life-cycle costs of bridges.

High Performance and Innovative Materials

High-Performance Concrete (HPC) Research and Deployment Program – The HPC program is a subset of the IBRD program. It continues the advancement of HPC applications through targeted research that addresses needed improvements in design, fabrication, erection, and long-term performance in order to achieve the Bridge Program strategic outcomes. HPC research focuses on material and casting issues, including improved performance criteria, lightweight concrete, curing, and test methods; structural performance concerns, including compression, shear, and fatigue behavior for both seismic and non-seismic applications; and concepts related to accelerated construction and bridge system design and performance.

High-Performing Steel (HPS) Research and Technology Program – The HPS research and technology transfer program is focused on resolving a number of issues and concerns with the design, fabrication, erection, and long-term performance of both conventional and High Performance steels. The program focuses research and technology transfer and education in the areas of materials and joining (for example, optimized welding processes and procedures); long-term performance (including advanced knowledge on performance limitations of

weathering steels and the potential development of a 100-year shop-applied permanent steel coating system); innovative design (including testing and deployment of modular steel bridge super- and substructure systems); and fabrication and erection tools and processes.

Ultra-High-Performance Concrete (UHPC) Research and Technology– UHPC is a unique material which is reinforced with short steel fibers, but requires no conventional steel reinforcing. Prior FHWA research on UHPC focused on basic material characterization, and the development of optimized structural systems using this very high performance, but costly, material. Under the UHPC program, additional work will be conducted to further understand the unique structural properties of this material and assess its corrosion-resistance properties, while addressing its use in other structural components including precast bridge deck panels and prestressed I- and bulb-tee girders.

Wood Composite Research – The University of Maine is conducting a research program focused in the development and application of wood/fiber reinforced polymer (FRP) composite materials for potential use as primary structural members in highway bridges.

Nondestructive Inspection Technology

Steel Bridge Testing Program – This program is focused on the further development and deployment of advanced NDE tools that can be used to detect and quantify growing cracks in steel bridge members and welds. As described in section 5202(d) of SAFETEA-LU, the NDE technology should ultimately be able to detect both surface and subsurface cracks, in a field environment, for flaws as small as 0.010 inches in length or depth.

Seismic Research

Seismic Research Program – The University of Nevada, Reno, and the State University of New York at Buffalo are conducting a seismic research program intended to increase the resilience of bridges and reduce earthquake-induced losses due to highway damage.

In addition to FHWA, numerous other entities conduct bridge research and technology development, including State DOTs, industry, other Federal agencies, and academia. The railroad industry, for example, conducts limited bridge research. FHWA works with these stakeholders and partners to actively coordinate a National research program for agenda-setting, to carry out research, and to deploy new innovations to improve the safety, performance, and durability of highway bridges.

FHWA staff participate in numerous national and international organizations and serve on committees focused on bridge research, development, and technology transfer. We organize formal technical advisory groups and technical working groups, comprised of Federal, State, and local transportation officials; bridge engineering consultants and

industry groups; and academia to assist in the design, conduct, and delivery of the program.

An important R&T partner for FHWA is the University Transportation Centers (UTC) Program, managed by the Research and Innovative Technology Administration (RITA). RITA also consolidates bridge technology information from all of the Department's modal administrations to assist us in having the best available technologies. FHWA works with the UTCs to identify opportunities for collaboration that will increase knowledge and skills among State and local highway agencies. We sponsor a variety of events that bring together researchers and practitioners from FHWA, State DOTs, TRB, and UTCs to learn about each others' interests and capabilities, new research opportunities, and technologies under development. Activities include annual workshops showcasing the results of UTC research on particular topics, and numerous conferences, seminars and workshops co-sponsored with specific UTCs. For example, the Northwestern University Infrastructure Technology Institute in Evanston, Illinois--a National UTC--works directly with infrastructure practitioners from across the country, particularly in nondestructive testing and evaluation, to solve problems and develop innovative technology applications in response to specific requests. FHWA also utilizes its highly successful Local Technical Assistance Program (LTAP) as a mechanism for transferring technologies developed through the UTC Program to State and local highway agencies, and tribal governments.

In addition, FHWA is an active participant with the American Association of State Highway and Transportation Officials (AASHTO) in technology transfer such as the AASHTO Technology Implementation Group and the Joint AASHTO/ FHWA/National Cooperative Highway Research Program International Technology Exchange Program, more commonly known as the International Scanning Program. Recent scans have included a scan on bridge management, and a follow-on scan in 2007 on Bridge Evaluation Quality Assurance. The 2007 scan identified and explored bridge inspection processes in use in European countries.

Ultimately, a key measure of success of any highway technology depends on its acceptance by stakeholders on a national scale. FHWA's responsibilities for R&T include not only managing and conducting research, but also sharing the results of completed research projects, and supporting and facilitating technology and innovation deployment. FHWA's Resource Center is a central location for obtaining highway technology deployment assistance. (The multiple services offered by the Resource Center are listed at www.fhwa.dot.gov/resourcecenter/.) Education and training programs are provided through the FHWA NHI (www.nhi.fhwa.dot.gov).

There are a number of barriers to technology deployment by State and local highway agencies and their contractors that may explain the relatively slow adoption of highway technologies that appear cost effective. Lack of information about new technologies is one barrier that may be overcome with information and outreach programs. Long-standing familiarity with existing technologies gained through education or experience also may hamper the adoption of newer technologies. Education and

training programs provided through the NHI often help to transcend these types of barriers.

It also may be difficult for stakeholders to envision the long-range benefits of a new technology relative to initial investment costs, especially if the payback (break-even) period is long. Even if stakeholders are aware of eventual cost savings from a more efficient or effective highway technology, they may have more confidence in traditional ways of, for example, assessing pavement performance. Demonstration projects that provide hard quantitative data can help tip the scales so that stakeholders are more willing to try and eventually regularly use innovative technologies.

Despite these efforts, technology deployment is also slowed by residual uncertainties about performance, reliability, installation, and maintenance costs; availability of the next generation of the technology; and the need for the necessary technical and physical infrastructure to support the technology in question. These persistent barriers can be addressed with outreach programs and collaborative efforts with stakeholders, ranging from the TRB to researchers within State DOTs, as well as other incentives to enhance the cost effectiveness of new technologies. Taken together, these initiatives often encourage earlier and broader adoption of highway technologies by increasing stakeholder familiarity with new technologies.

FHWA's Highways For LIFE (http://www.fhwa.dot.gov/hfl/hflfact.cfm) is one example of such an initiative. The purpose of Highways for LIFE is to advance long lasting highways using innovative technologies and practices to accomplish fast construction of efficient and safe pavements and bridges, with the overall goal of improving the driving experience for America. The program includes demonstration construction projects, stakeholder input and involvement, technology transfer, technology partnerships, information dissemination, and monitoring and evaluation. The innovative technologies that the Highways for LIFE program promotes include prefabricated bridge elements and systems, road safety audits, and tools and techniques for "Making Work Zones Work Better."

Perhaps the main barrier to technology deployment is the general lack of incentive mechanisms to encourage the deployment of new technologies. We need to develop better incentive mechanisms in the way the Federal-aid highway program is designed, the way we procure, and the extent to which we rely on the private sector.

The Missouri Safe and Sound Bridge Improvement Project provides an example of a potentially innovative way to improve incentives and encourage innovation and private sector participation.

On May 25, 2007 the Department of Transportation approved a $600 million allocation of Private Activity Bonds to the Missouri DOT for the Missouri Safe and Sound Bridge Improvement Project. The allocation will be made available to two short-listed bidders who are competing for a contract to bring 802 of Missouri's lowest rated bridges up to satisfactory condition by December 2012 and keep them in that condition

for at least 25 years. The contract will be awarded largely on the basis of the lowest level of "availability payments" that the bidder will accept to improve and maintain the 802 bridges. Missouri DOT will use Federal formula funds to pay the availability payments. SATETEA-LU authorized $15 billion in Private Activity Bonds. These bonds provide tax-exempt financing for private firms to carry out highway and surface freight transfer projects. Using this innovative financing approach will allow Missouri to complete these much needed bridge improvements more quickly and, it is hoped, at a lower cost. Other States, including Pennsylvania and North Carolina, are also interested in this innovative approach.

Through these and other mechanisms, FHWA supports the development and implementation of innovative technology deployment practices and processes throughout the highway community.

Conclusion

The I-35W bridge collapse was both a tragedy and wake-up call to the country. The Department's Inspector General will be monitoring all of the investigations into the collapse and reviewing our inspection and funding programs to decide and advise us what short- and long-term actions we may need to take to improve the bridge program. Though we will have to wait for the NTSB's report before we really know the cause of the collapse, a top-to-bottom review is underway to make sure that everything is being done to keep this kind of tragedy from occurring again. The public deserves to know and trust that our Nation's highways are safe.

Thank you again for this opportunity to testify. We will be pleased to answer any questions you may have.

Questions for the Record for Mr. King Gee
Associate Administrator for Infrastructure
Federal Highway Administration
Questions from Representative Christopher P. Carney
Subcommittee on Highways and Transit Hearing on Bridge Inspection Standards
October 23, 2007

QUESTION 1: Since the 1988 regulation issued by FHWA that allows the extension of inspection intervals, do we know how many bridges' inspection intervals have been extended? Are you able to accurately and specifically identify those bridges that have had their inspection intervals extended?

ANSWER: According to National Bridge Inventory (NBI) data from December 2006, there are 28,712 bridges with a routine inspection frequency greater than 24 months. The specific bridges can be identified from the NBI data. The accuracy of the data is dependent upon the efforts put forth by the States to ensure data quality. We believe that States accurately report this data based upon feedback received by FHWA division staff following their annual compliance reviews.

QUESTION 2: Is the Bridge Condition Rating data shared freely with the state/feds? Is there a close working relationship?

ANSWER: Yes, bridge condition ratings are shared as part of the National Bridge Inventory (NBI) data. The NBI data is available on the FHWA's Website at http://www.fhwa.dot.gov/bridge/nbi/ascii.cfm. We work closely with the States to compile the data on an annual basis.

QUESTION 3: I understand why we would want to conduct a Bridge Condition Rating inspection and then calculate from that a load rating for a particular bridge, but it seems to me – if I understand correctly – that Bridge Condition Rating inspections weren't enough and so a load rating inspection was instituted. This doesn't make sense to me. Either a bridge can handle the traffic it experiences or it can't. Am I missing something? Does this just seem more confusing that it is? I shudder to think that such confusion contributed in any manner to the I-35W catastrophe.

ANSWER: The National Bridge Inspection Standards (NBIS) require all bridges (as defined in the NBIS) to be load rated to their safe load-carrying capacity (23 CFR 650.313). The NBIS also define the different types of inspections (routine, underwater, fracture critical member, damage, in-depth, and special inspections). The "routine" inspection is the most common type of bridge inspection performed. These regularly scheduled inspections include examining all the individual parts of a bridge, assigning condition ratings for structural elements and appraisal ratings for other components, recording the physical and functional condition, identifying possible future problems, reviewing previous inspection reports and data, and determining the in-service safety of the bridge. From the information and the data that is collected from the "routine"

inspection, a determination for a bridge load re-rating can be made. The I-35W bridge had undergone several routine inspections as well as in-depth inspections. According to MNDOT data, the bridge had also been load rated several times in its lifetime and was determined capable of safely carrying legal traffic loads.

Questions for the Record for Mr. King Gee
Associate Administrator for Infrastructure
Federal Highway Administration
Questions from Chairman DeFazio
Subcommittee on Highways and Transit Hearing on Bridge Inspection Standards
October 23, 2007

Chairman DeFazio
The IG's report raised serious concerns about states inaccurately posting load ratings. In the 2006 audit, the IG found that States erred in calculating the load rating for structurally deficient bridges on the NHS. According to the DOT IG, inaccurate or outdated maximum weight limit calculations and posting entries were recorded in bridge databases of the state departments of transportation and the National Bridge Inventory.

The IG projects that among structurally deficient bridges on the NHS:

- one of 10 structurally deficient NHS bridges had load rating calculations that did not accurately reflect the condition of the structure;

- signs were not posted on 7.8 percent of bridges that were required to have maximum safe weight signs posted; and

- procedures were not properly followed in the calculation of load ratings for 10 percent of the bridges.

The IG also expressed concerns with the FHWA Division Offices oversight of States' bridge load ratings calculations and corresponding postings. In addition, FHWA does not require its Division Offices to analyze bridge inspection data to better identify and target specific structurally deficient bridges most in need of load limit recalculation and posting.

QUESTION 1(a): What has been FHWA's response to the March 2006 IG report and the September 2007 IG testimony before this committee on bridge inspection oversight?

ANSWER: FHWA concurred in the recommendations of the Office of the Inspector General (OIG) report dated March 21, 2006, *Audit of Oversight of Load Ratings and Postings on Structurally Deficient Bridges on the National Highway System*. FHWA responded to the recommendations by immediately convening a working group to evaluate options and make recommendations for improvements to current practices. The working group developed several tools to assist FHWA field offices in:

- Conducting bridge load rating and posting risk assessments
- Conducting in-depth reviews of States' bridge load rating and posting practices
- Conducting National Bridge Inspection Standards (NBIS) compliance reviews
- Identifying inaccuracies and inconsistencies in the bridge inspection program and associated data

The working group has also been involved in:

- Developing clarification of FHWA positions/policies through an update of the web-based NBIS Questions & Answers
- Evaluating and developing a portable National Bridge Inventory (NBI) computer to assist in oversight
- Providing input in the development of a new National Highway Institute Load and Resistance Factor Rating training course
- Providing input to the draft AASHTO Manual for Bridge Evaluation which addresses load rating and posting

In response to the recommendation to evaluate greater use of computerized bridge management systems to improve States' bridge inspection programs and enhance the accuracy of bridge load ratings, FHWA continues to provide bridge management technical assistance and training, as well as conduct executive sessions and share case studies with State transportation departments.

All of the above activities will continue into 2008 and beyond.

QUESTION 1(b): What steps is FHWA taking to improve the accuracy and completeness of the National Bridge Inventory data?

ANSWER: The FHWA has taken several steps to improve the accuracy and completeness of the NBI data, including the following:

- A procedure is in place to check each annual NBI data submittal for errors and inconsistencies. This gives the States and Federal agencies an opportunity to correct errors prior to loading the data in the national database. Files with significant errors are not loaded and are returned for revisions.

- FHWA performs several checks dealing with specific data items in addition to the annual error-checking program and works with stakeholders to correct the data as needed. Several standard reports are available for use by FHWA field offices to identify potential data quality issues. There is also an ad-hoc reporting feature available for field office use.

- FHWA Division Offices monitor bridge data quality during annual NBIS program reviews.

- As part of the 2005 NBIS regulation update, FHWA introduced a requirement for quality control and quality assurance (QC/QA) procedures. It is the responsibility of the States and Federal agencies who own bridges to implement quality control and assurance measures to ensure that the data is good before it is submitted to FHWA.

- The 2005 NBIS regulation update also introduced a requirement for bridge inspection refresher training as part of the QC/QA procedures. One of the main reasons for this training requirement is to refresh inspector skills and knowledge with respect to proper recording of NBI data.

- Through the Bridge Management Information Systems Laboratory at the FHWA Turner-Fairbank Highway Research Center (TFHRC), various studies have been conducted to identify opportunities to improve NBI data quality. For example, a study was conducted in 2006 to investigate NBI data quality in terms of accuracy of codes, consistency of values over time, and reasonableness of values when cross-checked with other items. Results from the study have been and will continue to be used to focus future training and guidance development efforts.

- FHWA is in the process of updating the current document that is used to provide instructions for collecting and reporting NBI data. A primary objective of this effort is to provide clarification for those items that have been identified as having coding inconsistencies or accuracy concerns.

- FHWA continually maintains and updates a suite of NHI bridge inspection training courses. A primary learning outcome from these courses is for participants to understand how to properly identify and code NBI data items.

FHWA continues to play an active role in identifying data quality issues and to work in partnership with the States and Federal agencies to make improvements.

Chairman DeFazio
You state that routine, visual inspection is the primary method used to perform routine bridge inspections.

QUESTION 2(a): Is it the position of FHWA that routine, visual inspection should continue to be the primary method employed by bridge inspectors?

ANSWER: Yes. Detailed visual inspection is highly effective in detecting serious defects and conditions that would compromise the safety of a bridge and is the preferred method for bridge safety assessment. Visual inspection is the primary method used to perform routine bridge inspections, supplemented by tools for cleaning, probing, sounding, and measuring. On occasion, destructive tests are conducted to evaluate specific areas or materials of concern, or to help identify appropriate rehabilitative work. Type, location, accessibility, and condition of a bridge, as well as type of inspection, are some of the factors that determine what methods of inspection are used. When problems are detected, or during the inspection of critical areas, non-destructive evaluation (NDE) methods and other advanced technologies are employed.

QUESTION 2(b): What actions has FHWA taken to increase the depth of inspections and the technology utilized in these inspections?

ANSWER: With respect to the depth of inspections, the 2005 update to the NBIS regulation incorporated by reference the American Association of State Highway and Transportation Officials (AASHTO) Manual for Condition Evaluation of Bridges. The AASHTO manual defines the depth of inspections for the various inspection types as well as technology to be utilized.

The NBIS regulation also now requires the establishment of criteria to determine the level of and frequency for inspection of certain bridges, considering such factors as age, traffic characteristics, and known deficiencies. In addition, specific inspection procedures are required for certain categories of bridges such as fracture critical and complex bridges.

FHWA has developed a multi-faceted approach to encouraging the acceptance and adoption of modern inspection methods and technologies:

- FHWA shares the results of completed research projects, and supports and facilitates technology and innovation deployment, through outreach programs and collaborative efforts with stakeholders, ranging from the Transportation Research Board to State departments of transportation.

- Education and training programs are provided through the FHWA National Highway Institute (NHI), and modern methods and technologies are introduced through these training courses.

- Demonstration projects and case studies that provide hard quantitative data can help to tip the scale so that stakeholders are willing to apply innovative technologies to long-standing safety and asset measurement and protection problems.

Through these and other mechanisms, FHWA supports the development and implementation of innovative technology deployment practices and processes throughout the highway community.

Taken together, these activities often encourage broad adoption of highway technologies by increasing stakeholder familiarity with new technologies. However, it is important to recognize that technology deployment is often slowed by residual uncertainties about performance, reliability, and installation and maintenance costs; availability of the next generation of the technology; and the need for the necessary technical and physical infrastructure to support the technology in question.

Over the past 15 to 20 years, a number of bridge inspection and monitoring technologies have been developed or supported through the efforts of FHWA's TFHRC. Overall, we can identify approximately 15 specific sensors and system types, many of which have been commercialized or are currently being refined for use by the commercial sector. Examples of these technologies include the following:

- FHWA developed a system to measure vertical and rotational stiffness of bridge foundations using truck loads as a method to differentiate between shallow and deep foundations on bridges where the foundation type is unknown. The methodology was subsequently commercialized and is currently available from a firm located in Arlington, MA.

- FHWA developed 3-dimensional imaging capabilities using ground penetrating radar (GPR) technology, enhancing the ability of GPR to detect deterioration in concrete bridge decks. The technology has been adopted by commercial GPR venders and is used for rapid evaluations of multiple bridge decks, providing information for bridge management and asset management decision-making.

- FHWA developed a sensor to passively measure the maximum strain experienced on a bridge to detect and quantify overloading. The sensor has been commercialized and is currently available from a firm in Alpharetta, GA.

- In cooperation with Southwest Research Institute (San Antonio, TX), FHWA developed and evaluated systems for testing large bridge cables using the magnetic flux leakage principle. The technology has since been commercialized and is being marketed by several companies.

- FHWA developed methods and engineered systems for rapidly applying thermal imaging for the detection of defects in concrete bridge components. This has since been commercialized and is marketed as Infrared Thermography, and is used on a limited basis for bridge inspection.

FHWA continues to support the development of new bridge inspection and monitoring technologies and to assist in the improvement of existing technologies. We also actively promote and provide assistance in the use of these systems. Ultimately, however, a key measure of success of any highway technology depends on its acceptance on a national scale by stakeholders.

Chairman DeFazio
A study released by FHWA in 2001 showed that visual inspection by trained bridge inspectors from around the country of bridges with identified fatigue problems rarely detected defects. In fact, the study found that only 8 percent of the inspectors correctly identified a fatigue crack, and many of the inspectors identified non-existent problems.

Similarly, a 2004 study published in the Journal of Bridge Engineering found significant problems with accuracy and reliability of viable inspections and documentation.

While the FHWA study had a small sample, the similar findings in these studies raises significant concerns, and a serious flaw in the current program—visual inspections remain the primary method used in bridge inspections. It raises serious concerns that our nation's primary means of determining bridge conditions is based on subjective assessments.

QUESTION 3: What is DOT and FHWA doing to increase its oversight of the bridge inspection program to ensure that proper inspection training, procedures, techniques and technology are being fully utilized and implemented in a uniform manner to mitigate human error and subjective assessments?

ANSWER: There are several recent examples of increased oversight activities. As a result of the recent Office of Inspector General (OIG) audit of FHWA's oversight of bridge load rating and posting practices, we have initiated in-depth reviews of each State's bridge load rating and posting procedures. FHWA also developed several standard reports that are generated from data in the National Bridge Inventory (NBI) as tools for monitoring and addressing data quality issues. As a result of National Bridge Inspection Standards (NBIS) regulation provisions, which became effective in January 2005, FHWA increased oversight of follow-up actions taken in response to critical bridge inspection findings, plans of action for scour critical bridges, fracture critical bridge inspections, and quality control/quality assurance.

FHWA's array of bridge inspection training courses serve as an effective means of ensuring that proper inspection training, procedures, techniques and technology are being implemented in a uniform manner to mitigate human error and minimize subjectivity in inspections. In the last few years, FHWA has revised the Bridge Inspector's Reference Manual and developed a new course in underwater bridge inspection. Currently, we are reviewing methods to allow the "Safety Inspection of In-Service Bridges" course to be presented over the internet to allow better access to this material.

Background:

FHWA Division Offices are responsible for providing oversight of each State's bridge inspection program. The primary means of monitoring the State program is through a comprehensive annual review. The review includes a look at overall compliance with the NBIS as well as the quality of bridge inspection.

A typical review consists of a field check of several bridges to compare inspection reports for quality and accuracy; interviews with bridge inspection staff to review procedures; and a review of various inventory data reports to assess compliance with such things as frequencies, load posting, and data accuracy. Annual reviews are supplemented with periodic in-depth reviews of specific program areas.

The FHWA Resource Center assists in oversight by providing expert technical assistance to Division Offices and partners; assisting in development and deployment of policies, technologies, and techniques; and deploying market-ready technologies. Also, the FHWA Resource Center assists in coordinating and conducting bridge inspection reviews and program exchanges, as well as delivering and updating training.

FHWA Headquarters' oversight responsibilities include issuing bridge inspection policies and guidance; maintaining the NBI; monitoring and updating our array of bridge

inspection training courses; collecting, reviewing, and summarizing the Division Office annual reports; and monitoring overall NBIS compliance.

Chairman DeFazio
Improved inspection techniques and frequencies could also substantially lower the risk of another catastrophic bridge failure that takes many innocent lives.

QUESTION 4: What is DOT and FHWA doing to dramatically upgrade the reliability and timeliness of identifying bridge deficiencies so that we can catch problems sooner and repair these structures at lower cost?

ANSWER: FHWA published a research report in 2001 entitled *Reliability of Visual Inspection for Highway Bridges*. As part of the 2005 update to the National Bridge Inspection Standards (NBIS) regulation, FHWA identified improvements to the regulation that would help address the findings from the research.

Specifically, the NBIS regulation was revised to incorporate a requirement to establish quality control/quality assurance procedures. These procedures are required to incorporate a bridge inspection refresher training component. Also, training requirements were added as part of the enhanced inspection Team Leader and Program Manager qualification provisions.

Improved inspection and measurement technologies have been a high priority for FHWA bridge research for more than twenty years. Over that time, FHWA has sponsored dozens of research projects in this area, a number of which have resulted in commercially available technologies and methods.

The current Research and Technology program is, however, somewhat limited. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) provided funding for only one program in bridge inspection/non-destructive evaluation (NDE) technology. This program, called "Steel Bridge Testing" (section 5202(d); 119 Stat. 1787), is focused on improving the technology for characterizing fatigue cracks in steel bridge members. Other NDE technology programs are being conducted via leveraged funding with States, the National Science Foundation, and others.

Since the mid-1980s, FHWA has been developing tools, approaches, and programs for facilitating effective bridge management, and providing training and technical assistance to agencies as they implement these tools and programs. These Bridge Management Systems (BMS) assist bridge-owning agencies in making rational maintenance, repair, rehabilitation, and replacement decisions based on actual bridge condition data. All States have implemented some type of BMS, recognizing the value of such tools from both a technical and financial standpoint. The most widely used BMS is Pontis, which was developed by FHWA in the early 1990s and has been continuously maintained and upgraded since then. A BMS assists bridge owners by providing optimal timing and

funding allocations for maintenance, repair, and replacement decisions based upon either constrained, or unconstrained, funding availability over both the short- and long-term.

With respect to the timeliness issue, the 2005 NBIS regulation introduced specific provisions for follow-up on critical findings, which are defined in the regulation as structural or safety related deficiencies that require immediate follow-up inspection or action.

Chairman DeFazio
I recognize that there are significant variations between bridges and environmental conditions, but there is no consistent federal standard for inspection of structurally deficient bridges. There is no federal requirements regarding the frequency or the depth of inspections required on high vulnerability structurally deficient bridges. Currently, the only federal requirement is that a bridge—regardless of its condition—be visually inspected once every two years. States chose to conduct inspections of these bridges more frequently, but this is all that is required under federal regulations.

QUESTION 5(a): Do you believe developing a uniform, consistent approach regarding the type of inspections and the frequency of vulnerable bridges would be beneficial?

ANSWER: Yes, and a uniform, consistent approach exists. The established National Bridge Inspection Standards (NBIS) (23 CFR 650 Subpart C) not only define the frequency and types of inspections (routine, underwater, fracture critical member, damage, in-depth, and special inspections), they also define procedures to be used in inspecting and rating highway bridges, quality control/quality assurance, as well as follow up on critical findings. FHWA will continue to update the NBIS as necessary and will closely consider any suggested revisions that result from the ongoing audit by the Department of Transportation Office of Inspector General of the national bridge inspection program or the National Transportation Safety Board investigation into the Minneapolis I-35W bridge collapse.

QUESTION 5(b): Would uniform standards make oversight of state programs easier, and ensure that data submitted to the National Bridge Inventory is consistent?

ANSWER: Yes, and uniform standards exist. The established NBIS set the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151. Annually, FHWA Division Offices review State compliance with the NBIS as well as the overall quality of the State's bridge inspection program. The established Highway Bridge Replacement and Rehabilitation Program (23 CFR 650 Subpart D) defines procedures for consistent data submittal to the National Bridge Inventory (NBI).

QUESTION 5(c): Do you agree that implementing such requirements for the most vulnerable bridges would lead to a data driven, performance-based program that

ensure the priority is placed on the bridges in the most need of repair or reconstruction?

ANSWER: Since uniform standards for the National Bridge Inspection Program are already in place and consistent data is being reported to the National Bridge Inventory (NBI), States are currently using data-driven approaches to programming their bridge activities.

The NBI data is currently used in the initial prioritization to identify structures that need attention and for the apportionment of Federal bridge funds to the States. The States, with more detailed information on their structures, are in the best position to identify their specific needs, and the final selection of bridge projects currently rests with the States.

States utilize bridge management systems of varying levels of complexity to identify their needs and assemble their programs. FHWA supported the development of Pontis, a bridge management program, and is currently offering support and classes in its use for the States.

Because bridge owners are the ones most familiar with the specific situations surrounding their bridge inventories, the current approach for identifying highest priority bridge needs at the State level is considered appropriate.

QUESTION 5(d): Can you talk about the steps FHWA is taking to improve the quality of data submitted to the NBI?

ANSWER: The FHWA has taken several steps to improve the quality of the National Bridge Inventory (NBI) data, including the following:

- A procedure is in place to check each annual NBI data submittal for errors and inconsistencies. This gives the States and Federal agencies an opportunity to correct errors prior to loading the data in the national database. Files with significant errors are not loaded and are returned for revisions.

- FHWA performs several checks dealing with specific data items in addition to the annual error-checking program and works with stakeholders to correct the data as needed. Several standard reports are available for use by FHWA field offices to identify potential data quality issues. There is also an ad-hoc reporting feature available for field office use.

- FHWA Division Offices monitor bridge data quality during annual NBIS program reviews.

- As part of the 2005 NBIS regulation update, FHWA introduced a requirement for quality control and quality assurance (QC/QA) procedures. It is the responsibility of the States and Federal agencies who own bridges to implement quality control

and assurance measures to ensure that the data is good before it is submitted to FHWA.

- The 2005 NBIS regulation update also introduced a requirement for bridge inspection refresher training as part of the QC/QA procedures. One of the main reasons for this training requirement is to refresh inspector skills and knowledge with respect to proper recording of NBI data.

- Through the Bridge Management Information Systems Laboratory at the FHWA Turner-Fairbank Highway Research Center, various studies have been conducted to identify opportunities to improve NBI data quality. For example, a study was conducted in 2006 to investigate NBI data quality in terms of accuracy of codes, consistency of values over time, and reasonableness of values when cross-checked with other items. Results from the study have been and will continue to be used to focus future training and guidance development efforts.

- FHWA is in the process of updating the current document that is used to provide instructions for collecting and reporting NBI data. A primary objective of this effort is to provide clarification for those items that have been identified as having coding inconsistencies or accuracy concerns.

- FHWA continually maintains and updates a suite of NHI bridge inspection training courses. A primary learning outcome from these courses is for participants to understand how to properly identify and code NBI data items.

FHWA continues to play an active role in identifying data quality issues and to work in partnership with the States and Federal agencies to make improvements.

Question 5(e): Do states have consistent, effective quality assurance and quality control procedures in place?

ANSWER: The 2005 update to the NBIS regulation introduced a requirement for States and Federal agencies to assure systematic quality control and quality assurance (QC/QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Periodic field review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations are to be included in the procedures.

There is limited experience within State and Federal agencies regarding effective practices for implementing the wide variety of possible methods for QC/QA. Currently, according to the FHWA's latest round of annual compliance reviews, nearly all States either have QA/QC procedures in place or under development. The variability in QC/QA practices across the country matches the expected variability in individual inspection programs (size and complexity of bridge inventory, available resources, etc.).

Measuring the effectiveness of QC/QA practices is a challenging task. There are a few States who are attempting to measure the effectiveness of their practices. In addition, FHWA and AASHTO have learned a great deal from their international counterparts. As a result of the NBIS regulation update and a recent international scanning tour, a National Cooperative Highway Research Program (NCHRP) project has been initiated to develop improved practices for QC/QA to further enhance the safety of highway bridges, improve the quality and reliability of bridge inspection practices, and enable progressive approaches for administering an inspection program. The objective of the NCHRP project is to develop a guideline document that can be used for implementing QC/QA practices within existing bridge inspection programs.

Chairman DeFazio
In your testimony, you talk about implementing incentives to increase the utilization of advanced technology for bridge inspections.

QUESTION 6: Can you talk about the types of incentives you believe will be beneficial and what changes to FHWA's procurement requirements would be required to implement these incentives?

ANSWER: FHWA's testimony stated that technology deployment is often slowed by residual uncertainties about performance, reliability, installation, and maintenance costs; availability of the next generation of the technology; and the need for the necessary technical and physical infrastructure to support the technology in question. We further stated that these persistent barriers can be addressed with outreach programs and collaborative efforts with stakeholders, ranging from the Transportation Research Board to researchers within State departments of transportation (DOTs), as well as other incentives to enhance the cost effectiveness of new technologies. As used in the testimony, "incentives" was meant to refer to various initiatives that often encourage earlier and broader adoption of highway technologies by increasing stakeholder familiarity with new technologies.

FHWA's Highways For LIFE (http://www.fhwa.dot.gov/hfl/hflfact.cfm) is one example of such an initiative. The purpose of Highways for LIFE is to advance long lasting highways using innovative technologies and practices to accomplish fast construction of efficient and safe pavements and bridges, with the overall goal of improving the driving experience for America. The program includes demonstration construction projects, stakeholder input and involvement, technology transfer, technology partnerships, information dissemination, and monitoring and evaluation.

Perhaps the main barrier to technology deployment for bridge inspections is the general lack of incentive mechanisms to encourage the deployment of new technologies. There is a need to develop better incentive mechanisms in the way the Federal-aid highway program is designed, the way we procure, and the extent to which we rely on the private sector.

The Missouri Safe and Sound Bridge Improvement Project provides an example of a potentially innovative way to improve incentives and encourage innovation and private sector participation. As discussed in more detail in the response to question 8 from Representative Napolitano, SAFETEA-LU authorized $15 billion in Private Activity Bonds. These bonds provide tax-exempt financing for private firms to carry out highway and surface freight transfer projects. On May 25, 2007, the Department of Transportation approved a $600 million allocation to the Missouri DOT of authority to issue Private Activity Bonds for the Missouri Safe and Sound Bridge Improvement Project. The allocation will be made available to two short-listed bidders who are competing for a contract to bring 802 of Missouri's lowest rated bridges up to satisfactory condition by December 2012 and keep them in that condition for at least 25 years. The Missouri DOT will use Federal formula funds to pay the availability payments.

Using this innovative financing approach will allow Missouri to complete these much needed bridge improvements more quickly and, it is hoped, at a lower cost.

Chairman DeFazio
A 2003 National Cooperative Research Program study found that trucks have a significant impact on the deterioration of bridges and reduction of bridge service life.

QUESTION 7(a): How has the FHWA worked with states to assist them in developing methodology to better account for increased truck traffic volumes?

ANSWER: The National Cooperative Highway Research Program Report 495, *Effect of Truck Weight on Bridge Network Costs*, provides a suggested methodology to estimate the impact of changes in truck weight limits on bridge "network" costs. It is not related to the rating or performance of an individual structure nor does it deal with growth in truck volume. Instead, the report discusses how to measure the potential impacts if legal loads are increased.

FHWA requires the use of a new design specification, the AASHTO Load and Resistance Factor Design (LRFD) bridge design specifications, which increased the design live load on highway bridges to encompass heavy truck weights around the country. FHWA has provided assistance to all States to implement this change. Further, the LRFD specifications recommend that owners consider site-specific modifications to the design truck when the expected trucks are heavier than usual or constitute unusually high percentages of roadway traffic.

FHWA is also providing assistance to States implementing the new Load and Resistance Factor Rating (LRFR) specifications which accompany the LRFD design specifications. At this stage, FHWA requires the use of the LRFR on bridges designed by LRFD. In the LRFR, owners can adjust their rating trucks to account for local or grandfathered truck configurations and can take into account heavier truck traffic volumes by increasing the load factor used in the load rating process.

While we are not aware of a specific program or research effort in which FHWA worked with any State to develop a methodology for measuring the impact of increased truck traffic on bridges, software known as BASIC (bridge assessment policy analysis software) can estimate the stresses and overstresses caused by any truck configuration on any bridge in the United States. The tool is a nationwide policy analysis tool, using mostly National Bridge Inventory (NBI) data. Consequently, although it is an excellent tool for nationwide policy analysis, it should not be used for a definitive analysis of a specific bridge because of inherent limitations. The software does not account for all members of the superstructure that add to a bridge's strength and it does not consider fatigue.

QUESTION 7(b): Can you talk about the practice of states providing overweight permits and the impact these permits have on bridge deterioration?

ANSWER: States are responsible for issuing all oversize/overweight permits that govern truck movement on highways within the State. These special use permits are controlled by bridge and highway geometry and condition, gross and axle weights, day and time of day travel, and other conditions necessary to insure safe travel.

Overweight permit trucks have little effect on a bridge if the rating of the truck is less than the actual *operating* rating of the bridge. The *operating* rating is the maximum permissible live load to which the structure may be subjected for the load configuration used in the rating. However, if the rating of the permit truck exceeds the *operating* rating of the bridge, then such trucks may have detrimental effects on these bridges.

Also, even if the rating of the truck is *less* than the operating rating but *more* than the *inventory* rating (i.e., the rating load level which can safely utilize an existing structure for an indefinite period of time) and the number of such permit trucks is significant, then again, there can be damage to these bridges.

Chairman DeFazio
As you know many of the nation's bridges span our waterways with critical support structures primarily under water. I am interested in the robustness of the underwater bridge inspection process and database. Recently, 6 states California, Missouri, North Dakota, South Carolina, Texas and Wisconsin requested a TPF program study on the utilization of underwater imaging technology for inspection of bridge substructures. The request stated "underwater inspection by divers requires methodical planning to ensure the safety of the dive team. Diving in turbid water or in high current decreases divers' safety and increases the potential for incomplete assessment of the submerged elements. Emergency inspection, as a result of earthquake or flooding, can take weeks to complete."

QUESTION 8(a): I understand that the most common form of underwater bridge inspection currently is for a diver, who may not be an engineer and in most cases is not, to proceed below surface with a two-way radio, conduct a sight and touch

inspection while communicating top-side with an engineer who then completes the required reports. Is this your understanding?

ANSWER: Under the National Bridge Inspection Standards (NBIS) requirements, underwater bridge inspection divers are not required to be engineers; however, they are required to complete comprehensive bridge inspection training or other FHWA approved training for underwater bridge inspection. The regulations also require that a qualified Team Leader be on-site during the inspection. The Team Leader may or may not be a diver. When a Team Leader is not also diving, he is often in contact with the divers through hard-wired communication channels. While we do not have information to confirm that the majority of divers currently involved in bridge inspections are not engineers, we suspect that to be true.

Diving certification through a nationally recognized training agency, physical fitness to dive attested to by a physician knowledgeable in underwater medicine, experience in zero visibility diving, and recent diving activity are also important considerations. Although engineer divers are considered desirable by many bridge inspection program managers, diving competence is the foremost requirement for any underwater inspector.

Underwater bridge members must be inspected to the extent necessary to determine structural safety with certainty. In wadeable water, underwater inspections can usually be accomplished visually or tactually from above the water surface. However, inspections in deep water will generally require diving or other appropriate techniques to determine underwater conditions.

The Transportation Research Board Circular Number 330, Underwater Bridge Inspection Programs, together with references, provides guidance for establishing underwater inspection programs and prioritizing these inspections. Three levels of underwater inspections are described in the circular:[1]

LEVEL I - a "swim-by" overview, with minimal cleaning to remove marine growth.

LEVEL II - limited measurements of damaged or deteriorated areas that may be hidden by surface biofouling. Marine growth is cleaned from a sample of underwater members in 10 inch wide bands at designated levels to enable close inspection.

LEVEL III - highly detailed inspections utilizing nondestructive tests such as ultrasound or minimally destructive tests such as coring of wood or concrete and in-situ hardness tests.

Routine underwater bridge inspections typically involve a LEVEL I inspection on 100 percent of the underwater portion of the structure to determine any obvious problems. Also, a LEVEL II inspection should be made on at least 10 percent of underwater units

[1] The guidance provided by TRB was adopted from U.S. Navy practices that originally defined Level I, II and III criteria.

selected at random to verify the LEVEL I inspection. The channel bottom and sides should be inspected for scour.

QUESTION 8(b): Are there instances where the water would be too murky or the current too dangerous for such a visual underwater inspection to take place?

ANSWER: Diving conditions for underwater bridge inspections (poor visibility, underwater obstacles, cold temperatures, and unpredictable currents) are often very challenging. Properly trained divers are aware of techniques and tools for use in extreme conditions including use of heavy weights for negative buoyancy, depth sounding, and line tending and safety divers. Divers trained for conditions of poor visibility and swift currents can perform good inspections safely.

Water clarity often limits the diver's ability to visually inspect the structure. In such cases, the inspector must use tactile senses to supplement or replace the visual inspections. Usually it is most effective if the diver examines the underwater elements by moving his hands and arms in large sweeping motions to cover all areas of each underwater element. Also, through the use of clear-water boxes, the diver can not only see damage or deterioration but can also document it in video and still photography.

QUESTION 8(c): What technology, if any, is used to enhance diver's safety and to provide an empirical database from an underwater inspection?

ANSWER: Underwater bridge inspectors must have training and certification both for technical diving and bridge inspection. Underwater diving safety is independent of the bridge inspection process and must comply with diving certification programs and requirements administered by others.

Underwater bridge inspection also requires careful advance planning to ensure the safety of the dive team. Technologies such as sonar scanning, underwater still and video cameras, and remote operated vehicles are utilized to collect inspection information and minimize diver exposure to risks associated with underwater inspections.

FHWA is participating in a pooled fund study, discussed below under Question 8(g), to research sonar-imaging and video technology; develop sonar inspection techniques, including remote-operated vehicles and sector scan sonar methods; analyze the quality of the sonar and video inspection results; and compare to diver conducted inspections.

QUESTION 8(d): Is an image of the underwater structure required to be in the inspection report?

ANSWER: While the NBIS regulation does not specifically require images of underwater bridge elements, it is common practice within the underwater bridge inspection community to obtain photographs and/or video. Underwater documentation in the form of color photography or video can be provided at an economical cost under almost all water conditions.

Standard camera units can be used underwater in waterproof cases commonly made of clear acrylic plastic and sealed with rubber gaskets. There are also waterproof cameras designed specifically for use underwater. These cameras can be equipped with a variety of lenses and electronic flash units for underwater photography. Coupled with clear-water boxes, documentation can be obtained in even zero visibility conditions.

QUESTION 8(e): Would a database be more robust with a requirement that a real-time image of the structure at the time of the inspection be included in each inspection report?

ANSWER: As previously noted, it is common practice within the underwater bridge inspection community to include photographs and/or video as part of the bridge inspection records. Underwater documentation in the form of color photography or video can be provided at an economical cost under almost all water conditions. A Federal requirement is not necessary.

QUESTION 8(f): Are you aware of the development by the US Coast Guard of a 3-D geo-referenced real-time sonar underwater inspection system (UIS) called the echoscope?

ANSWER: FHWA hydraulic engineers are somewhat familiar with the United States Coast Guard system, formally known as the Coda Underwater Inspection System (Coda UIS). Coda UIS uses sonar technology that is very common for determining scour development around bridge foundations, but is a system that has some additional features when compared to other commercially-available systems. The system, however, can not be used to assist in the underwater inspection of structural members or components for things like cracking, corrosion, or general deterioration. The Coda UIS, along with other commercially available sonar-based scour evaluation systems, can be mounted on a small boat to scan harbor bulkheads, cellular cofferdams, wharf piers, or bridge foundations. Many of these systems can also be mounted on remotely operated vehicles, but may be difficult to control in underwater bridge inspections. Therefore, systems like the Coda UIS can be used to supplement, but not replace, the underwater diving inspection of bridges.

QUESTION 8(g): Could you discuss this technology and other similar technologies and provide the committee with your comments on its application or enhanced divers safety and enhanced underwater bridge inspections?

ANSWER: As indicated above, sonar scanning systems like the Coda UIS can be used to supplement, but not replace, the underwater diving inspection of bridges.

Scanning technology has advanced significantly in the past few years, but research that investigates the current capabilities and limitations is needed. FHWA and several States are participating in a pooled fund study led by the California Department of Transportation. The objectives of the study are to research sonar-imaging and video

technology; develop sonar inspection techniques, including remote operated vehicles and sector scan sonar methods; and analyze the quality of the sonar and video inspection results and compare them to diver conducted inspections.

Questions for Mr. King Gee
Associate Administrator for Infrastructure
Federal Highway Administration
Highways and Transit Subcommittee Hearing
By Representative Grace F. Napolitano
October 23rd, 2007

QUESTION 1: How does the National Bridge Inspection Program assist states in evaluating the structural integrity of their bridges to withstand local natural disasters such as earthquakes, hurricanes, tornados, and floods?

ANSWER: Through regularly scheduled inspections that are conducted as part of the National Bridge Inspection Program, information is collected that assists bridge owners in evaluating the structural integrity of their bridges to withstand natural disasters such as hurricanes, earthquakes, and floods. Some of the collected information is included in the National Bridge Inventory, while additional information is often retained at the State or local level.

Occasionally, site-specific visits outside of the normal in-service bridge inspections are necessary in order to obtain the information required to properly evaluate the vulnerability of each bridge to the type of natural event that is under consideration.

QUESTION 2: The Beverly Bridge in my district burnt down in November of 2005 because of a homeless man that started a fire while camped under the bridge. We all know that bridges are plagued by homelessness because of the shelter that they provide. When bridge inspectors encounter homeless camps, do they ever consider the susceptibility of the bridge to destruction due to the vagrants who reside under the bridge?

ANSWER: Yes, bridge inspectors are aware of the risks introduced by the presence of vagrants who reside under or within a given bridge. Inspectors are trained to look for evidence of damage to bridge components from fire, along with other potential problems such as the collection of debris and construction of temporary shelters that may contribute to deterioration or impede the performance of the structure. Inspectors also make note of any damage to security devices, access hatches, or latches that may allow for entrance by vagrants or other trespassers.

Security and safety of the inspectors is also a concern. In many locations, inspectors must rely on police escorts to ensure their safety.

For many security threats, bridge owners must rely on rapid response from the police. A continuing presence of vagrants under a bridge increases the difficulty of detecting the presence of persons with malicious intent and may delay response to aggressor actions. If we allow aggressors access and plenty of time to carry out an attack, most of our structures are vulnerable to destruction by relatively small amounts of explosives or by ordinary non-explosive devices such as cutting torches or grinders.

QUESTION 3: Visual observation remains one of the primary methods for bridge inspectors to determine structural integrity even though studies have raised concerns with the reliability of visual inspections. A 2001 Federal Highway Administration report noted that only 8% of 49 trained bridge inspectors were able to correctly identify a fatigue crack. What is the FHWA doing to implement new methods and training for investigating bridge integrity?

ANSWER: The 2001 FHWA report identified several concerns with the type and quality of inspections at that time. However, it must be recognized that this was only a very limited sample and did not completely represent actual bridge inspection practices. The research methodology that was used had several important limitations, including the following:

- The inspectors involved in the project were not necessarily representative, or had the level of training required, of those who conduct in-depth or fracture critical member inspections, yet they were tasked to do so as part of this study.

- The inspectors involved in the study were not provided with any history on the sample bridges and were not able to take advantage of previous engineering analysis or information. Such information is typically reviewed by an inspector prior to conducting the next inspection on that same structure.

As a result of the study and its recommendations, a number of improvements were made to the National Bridge Inspection Standards. Specifically, the regulations were revised to incorporate a requirement to establish quality control/quality assurance procedures, along with additional training and refresher training requirements. Inspector training courses and certification requirements were also upgraded, providing for a higher level of inspector competency. And, a number of clarifications were provided to the definitions and descriptors that inspectors use in reporting the results of the inspections.

The results of this study were widely publicized by FHWA, thereby creating a broad awareness of the issues and greater attention to the need for improved quality. This report certainly provided a wakeup call regarding some aspects of the national bridge inspection program, and spurred significant improvements in the program. However, it is important to note that for the current investigation on the I-35W bridge in Minneapolis, there are no indications that the collapse occurred as a result of deficiencies in the State's inspection program.

QUESTION 4: How many federal certified bridge inspectors do we have in this country? Are they federal or state inspectors?

ANSWER: While the exact number of certified bridge inspectors in the U.S. is unknown, we estimate that there are more than 2,300 State, local, Federal, and consultant inspectors who are qualified as Team Leaders under the NBIS regulation. The population of bridge inspectors includes people from State, local, and Federal agencies, as well as consultants.

QUESTION 5: How often is the bridge inspector training manual updated?

ANSWER: The current Bridge Inspector's Reference Manual (BIRM) was first published in October 2002 as a comprehensive update to the previous reference document known as the Bridge Inspection Training Manual-90. The BIRM was most recently updated in December 2006.

Updates are pursued as needed due to changes in the program or practices rather than on a set schedule.

QUESTION 6: Do bridge inspectors receive continuing training in order to hold onto their certification?

Answer: The NBIS regulation (23 CFR 650.313(g)) requires State transportation departments and Federal bridge-owning agencies to assure systematic quality control and quality assurance (QC/QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program. The QC/QA procedures are to include periodic bridge inspection refresher training for program managers and team leaders along with periodic field review of inspection teams and independent review of inspection reports and computations. FHWA has developed a refresher training class through the National Highway Institute to assist the States in meeting these needs.

QUESTION 7: Can you expand on the statement in your testimony when you say, "We need to develop better incentive mechanisms in the way the Federal-aid highway program is designed, the way we procure, and the extent to which we rely on the private sector." How should we strengthen the procurement process?

ANSWER: The testimony stated that technology deployment is often slowed by residual uncertainties about performance, reliability, installation, and maintenance costs; availability of the next generation of the technology; and the need for the necessary technical and physical infrastructure to support the technology in question. We further stated that these persistent barriers can be addressed with outreach programs and collaborative efforts with stakeholders, ranging from the Transportation Research Board to researchers within State DOTs, as well as other incentives to enhance the cost effectiveness of new technologies. As used in the testimony, "incentives" was meant to refer to various initiatives that often encourage earlier and broader adoption of highway technologies by increasing stakeholder familiarity with new technologies.

FHWA's Highways For LIFE (http://www.fhwa.dot.gov/hfl/hflfact.cfm) is one example of such an initiative. The purpose of Highways for LIFE is to advance long lasting highways using innovative technologies and practices to accomplish fast construction of efficient and safe pavements and bridges, with the overall goal of improving the driving experience for America. The program includes demonstration construction projects, stakeholder input and involvement, technology transfer, technology partnerships, information dissemination, and monitoring and evaluation.

Perhaps the main barrier to technology deployment for bridge inspections is the general lack of incentive mechanisms to encourage the deployment of new technologies. There is a need to develop better incentive mechanisms in the way the Federal-aid highway program is designed, the way we procure, and the extent to which we rely on the private sector.

The Missouri Safe and Sound Bridge Improvement Project provides an example of a potentially innovative way to improve incentives and encourage innovation and private sector participation. As discussed in more detail in the response to question 8 below, SAFETEA-LU authorized $15 billion in Private Activity Bonds. These bonds provide tax-exempt financing for private firms to carry out highway and surface freight transfer projects. On May 25, 2007, the Department of Transportation approved a $600 million allocation to the Missouri DOT of authority to issue Private Activity Bonds for the Missouri Safe and Sound Bridge Improvement Project. The allocation will be made available to two short-listed bidders who are competing for a contract to bring 802 of Missouri's lowest rated bridges up to satisfactory condition by December 2012 and keep them in that condition for at least 25 years. The Missouri DOT will use Federal formula funds to pay the availability payments.

Using this innovative financing approach will allow Missouri to complete these much needed bridge improvements more quickly and, it is hoped, at a lower cost.

QUESTION 8: Can you give more information on how the Department is implementing the Private Activity Bonds of SAFETEA-LU? Has the state of California accessed this funding?

Section 11143 of Title XI of SAFETEA-LU amends Section 142 of the Internal Revenue Code to add highway and freight transfer facilities to the types of privately developed and operated projects for which private activity bonds (PABs) may be issued. This change allows private activity on these types of projects, while maintaining the tax-exempt status of the bonds. The law limits the total amount of such bonds to $15 billion and directs the Secretary of Transportation to allocate this amount among qualified facilities.

The Department published a Federal Register notice on January 5, 2006, inviting applications for PAB authority and explaining how the Department is implementing the PAB program. The Department considers applications for PAB authority in light of applicable statutory requirements and the availability of tax-exempt authority for the type and location of the project for which the allocation is requested.

While the Department has not specified a fixed format for applications, it has identified a number of pieces of information which would be helpful in facilitating its consideration of applications. These pieces of information are specified in Section B (Applications for Allocations) of the Federal Register notice, which is attached on the following pages and is available online at: http://www.fhwa.dot.gov/PPP/PAB_FRN.pdf.

As of November 2007, the Department has approved four allocations in the aggregate amount of $3 billion: (i) a $900 million allocation for the Port of Miami Tunnel Project in Florida, (ii) a $700 million allocation for the Safe & Sound Bridge Improvement Project in Missouri, (iii) a $600 million allocation for the Knik Arm Crossing Project in Alaska, and (iv) an $800 million allocation for the Capital Beltway HOT Lanes Project in Virginia. The Department has not received any applications for projects in California, but has had discussions with representatives of the San Francisco Bay Area Rapid Transit District (BART) about a prospective application for a $300 million allocation of PAB authority for the Oakland Airport Connector project.

DEPARTMENT OF TRANSPORTATION

Office of the Secretary of Transportation

[Docket No. OST–2005–23418]

Applications for Authority for Tax-Exempt Financing of Highway Projects and Rail-Truck Transfer Facilities

AGENCIES: Office of the Secretary of Transportation (OST), DOT.

ACTION: Notice of solicitation for requests for allocations of tax-exempt financing and request for comments.

SUMMARY: Section 11143 of Title XI of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users amends the Internal Revenue Code by creating a new class of tax-exempt facility bonds for qualified highway and surface freight transfer facilities. The law limits the total amount of such bonds to $15 billion and directs the Secretary of Transportation to allocate this amount among qualified facilities. This notice solicits requests for such allocations from interested entities that meet the statutory requirements. The Department also requests comments from the public that it may consider in its application of the authority provided by Section 11143.

DATES: Comments may be submitted at any time and will be considered as appropriate whenever they are submitted.

ADDRESSES: *Comments:* To make sure your comments and related material are not entered more than once in the docket, please submit them identified by docket number OST–2005–23418 by only one of the following means:

(1) *Web Site: http://dms.dot.gov.* Follow the instructions for submitting comments on the electronic docket site.

(2) *Fax:* 202–493–2251.

(3) *Mail:* Dockets Management Facility, U.S. Department of Transportation, M–30, Room PL–401, 400 Seventh Street SW., Washington, DC 20590.

(4) *Hand Delivery:* Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

Instructions: All submissions must include the agency name and docket number of this notice. Due to security procedures in effect since October 2001 on mail deliveries, mail received through the Postal Service may be subject to delays. Commentors should consider using an express mail firm to ensure the prompt filing of any comments not submitted electronically or by hand. Note that all comments received will be posted without change to *http://dms.dot.gov* including any personal information provided. Please see the Privacy Act heading under Regulatory Analysis and Notices.

Docket: For access to the docket to read background documents or comments received, go to *http://dms.dot.gov* at any time or to Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

Applications: Mr. Jack Bennett, Office of the Assistant Secretary for Transportation Policy, Office of Economic and Strategic Analysis (P–20), Room 10305–E, 400 Seventh Street SW., Washington, DC.

FOR FURTHER INFORMATION CONTACT: Jack Bennett, U.S. Department of Transportation, Office of the Assistant Secretary for Transportation Policy, Office of Economic and Strategic Analysis (P–20), 400 Seventh Street SW., Washington, DC 20590, (202) 366–6222.

SUPPLEMENTARY INFORMATION:

A. Statutory Background

Section 11143 of Title XI of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA–LU), Public Law Number 109–59, 119 Stat. 1144 (Aug. 10, 2005) (the Act), amends § 142 of title 26, United States Code (hereinafter referred to as the Internal Revenue Code or the Code) by adding sections 142(a)(15) and 142(m). These amendments create a new class of tax-exempt financing for qualified highway or surface freight transfer facilities. The law limits the amount of tax-exempt financing available under this provision to $15 billion nationally and charges the Secretary of Transportation with allocating this $15 billion among qualified facilities. The relevant statutory provisions of the Code include:

• Section 103(a) of the Code provides that, except as provided in section 103(b), gross income does not include interest on any State or local bond.

• Section 103(b)(1) provides that the exclusion under section 103(a) does not apply to any private activity bond that is not a qualified bond (within the meaning of section 141).

• Section 141(e) provides that the term "qualified bond" includes an exempt facility bond that meets certain requirements.

• New section 142(a)(15) provides that the term "exempt facility bond" includes qualified highway or surface freight transfer facilities.

• New section 142(m) defines the new class of exempt facility bonds for qualified highway or surface freight transfer facilities.

• Section 142(m)(1) defines "qualified highway or surface freight transfer facilities" as:

(A) Any surface transportation project which receives Federal assistance under title 23, United States Code (as in effect on August 10, 2005, the date of the enactment of section 142(m));

(B) Any project for an international bridge or tunnel for which an international entity authorized under Federal or State law is responsible and which receives Federal assistance under title 23, United States Code (as so in effect), or

(C) Any facility for the transfer of freight from truck to rail or rail to truck (including any temporary storage facilities directly related to such transfers) which receives Federal assistance under title 23 or title 49, United States Code (as so in effect).

Examples of intermodal freight transfer facilities for the transfer of freight from truck to rail or rail to truck include cranes, loading docks, and computer-controlled equipment that are integral to such freight transfers. Examples of facilities that are not freight transfer facilities include lodging, retail, industrial, or manufacturing facilities except to the extent that such facilities also include freight transfer activities.

• Section 142(m)(2)(A) provides a $15,000,000,000 national limitation on the aggregate amount of tax-exempt financing for qualified highway or surface freight transfer facilities allocated by the Secretary.

• Section 142(m)(2)(B) provides that an issue shall not be treated as an issue described in section 142(a)(15) for a qualified highway or surface freight transfer facility if the aggregate face amount of bonds issued pursuant to such issue for any qualified highway or surface freight transfer facility (when added to the aggregate face amount of bonds previously so issued for such facility) exceeds the amount allocated to such facility by the Secretary of Transportation under section 142(m)(2)(C).

• Section 142(m)(2)(C) provides that the Secretary of Transportation shall allocate the $15,000,000,000 national limitation among qualified highway or surface freight transfer facilities in such manner as the Secretary determines appropriate.

• Section 142(m)(3) provides that an issue shall not be treated as an issue described in section 142(a)(15) for a

qualified highway or surface freight transfer facility unless at least 95 percent of the net proceeds of the issue is expended for qualified highway or surface freight transfer facilities within the 5-year period beginning on the date of issuance. If at least 95 percent of such net proceeds is not expended within such 5-year period, an issue shall be treated as continuing to meet the 5-year spending requirements of section 142(m)(3) if the issuer uses all unspent proceeds of the issue to redeem bonds of the issue within 90 days after the end of such 5-year period. The Secretary of the Treasury, at the request of the issuer, may extend such 5-year period if the issuer establishes that any failure to meet such period is due to circumstances beyond the control of the issuer.

• Section 142(m)(4) provides an exception to the volume limit in section 142(m)(2) for any bond (or series of bonds) issued to refund a bond issued under section 142(a)(15) if:

(A) The average maturity date of the issue of which the refunding bond is a part is not later than the average maturity date of the bonds to be refunded by such issue (for this purpose "average maturity" is determined in accordance with section 147(b)(2)(A)),

(B) The amount of the refunding bond does not exceed the outstanding amount of the refunded bond, and

(C) The refunded bond is redeemed not later than 90 days after the date of the issuance of the refunding bond.

• Section 11143(c) of SAFETEA–LU provides that exempt facility bonds described in section 142(a)(15) for qualified highway and surface freight transfer facilities are exempt from general state volume caps on private activity bonds in section 146.

B. Applications for Allocations

Parties who wish to take advantage of the tax-exempt financing provided by Section 11143 of SAFETEA–LU are invited to apply to DOT for an allocation of this authority. Upon receipt of such an application, the Department will, after due consideration, either accept or reject the application, or communicate further with the applicant if additional information is needed to fully consider the application. The Department is not specifying any form for an application, nor is it requiring all or any of the information listed below to be included in the initial application. Nevertheless applicants may wish to include the following information to facilitate the Department's consideration of the application.

1. *Amount of Allocation Requested.*

2. *Proposed Date of Bond Issuance.* Provide the approximate date when it is anticipated that the tax-exempt bonds would be issued should authority to do so be allocated by the Department.

3. *Date of Inducement by the Bond Issuer.* Provide a copy of a resolution adopted in accordance with state or local law authorizing the issuance of a specific issue of obligations. The resolution may state that issuance of obligations is contingent upon receipt of an allocation from the Secretary of Transportation of a portion of the $15,000,000,000 national limitation.

4. *Draft Bond Counsel Opinion Letter.* Provide Form of Bond Counsel Opinion or date by which a draft letter will be provided.

5. *Financing/Development Team Information.* Provide the names of the issuer of the bonds, the borrower, and any other key participants in the financing, with complete contact information, including Federal taxpayer identification numbers.

6. *Borrower Information:* For each borrower, provide the official business name, ownership and legal structure (corporation, partnership, or sole proprietorship), Federal taxpayer identification number, and prior experience as it relates to carrying out projects similar to that proposed. For the purposes of this Notice, the term "borrower" includes any borrower of the bond proceeds or any other entity responsible for re-paying the bonds.

7. *Project Description.* Describe the project as a whole and the proposed organizational and legal structure of the project (ownership, franchise or lease arrangements, etc.). Describe the portion of the project and all capital assets to be funded with the proceeds of the exempt facility bonds. If the application is for an international bridge or tunnel under section 142(m)(1)(B), the project description should include a representation that the international entity that has responsibility for the project is authorized under Federal or state law.

8. *Project Schedule.* Provide a timeline showing the estimated start and completion dates for each major phase or milestone of project development. Indicate the current status of milestones on this timeline, including all necessary permits and environmental approvals.

9. *Financial Structure.* Provide a statement of anticipated sources and uses of funds for the project, including separate line items, as applicable, for proceeds of exempt facility bonds or other borrowing, Federal grants, state and local grants, other credit assistance, and private investment. Provide a projected drawdown schedule for the use of funds, project revenue and expenses, and sources of security and repayment for the bonds.

10. *Description of Title 23/49 U.S.C. funding received by the project.* Provide the date (or anticipated date) of receipt and types and amount of financial assistance.

11. *Project Readiness.* Describe the financing/development team's capacity to undertake this project. Discuss readiness to begin the project. List all major permits and approvals necessary for construction of the project and the date, or projected date, of the receipt of such permits or approvals. Include information on engineering work, and procurement of construction.

12. *Signatures.* Applications should be signed by a duly authorized representative of the proposed issuer and a duly authorized representative of each proposed borrower. Applications may be submitted by the proposed issuer or the proposed borrower.

13. *Declarations.* Each application, including any supporting reports or other document, should include the following declaration signed by an individual who has personal knowledge of the relevant facts and circumstances: "Under penalties of perjury, I declare that I have examined this document and, to the best of my knowledge and belief, the document contains all the relevant facts relating to the document, and such facts are true, correct, and complete."

14. *Addresses.* Applications should be submitted (with 10 copies) to: Mr. Jack Bennett, U.S. Department of Transportation, Office of the Assistant Secretary for Transportation Policy, P–20, Room 10305 E, 400 7th Street SW., Washington, DC 20590.

C. Consideration of Applications

Upon receipt, the Department will consider the application in light of applicable statutory requirements and the availability of tax-exempt authority for the type and location of the project for which the allocation is requested. If the Department needs additional information from the applicant, the Department will contact the applicant to arrange for the submission the required information.

In making application to the Department, applicants should note that there are no specific standards beyond those set forth in applicable laws or regulation that apply to the consideration of the applications.

The Department is particularly concerned that once it makes an allocation, tax-exempt facility bonds are

issued in timely fashion. Hence, if the schedules agreed upon in the final allocation action are not met, the allocation may be withdrawn.

D. Compliance With Rules Governing Qualified Private Activity Bonds

The application process described in this Notice only goes to allocation of tax-exempt financing by the Department of Transportation. All representations made as part of this application process are subject to verification on examination. In addition, except as otherwise provided in this Notice, nothing in this Notice shall be construed as overriding any requirements or limitations applicable to exempt facility bonds found in sections 103 and 141 through 150 of the Code and the applicable regulations thereunder, or affecting the ability of the IRS to examine the bond issue for compliance with those requirements or limitations.

E. Request for Comments

Interested parties are invited to provide comment on how the Department should exercise the allocation authority provided by Section 11143 of SAFETEA–LU. Comments may address both the process described in this notice and any other matters that the commenter believes would be useful for the Department to consider in its administration of this provision of SAFETEA–LU. This is new authority for the DOT, and the Department will be continually examining its implementation of this provision to ensure that allocations are occurring in a fair and reasonable manner, that this tax-exempt bonding authority is fully utilized, and that this financing opportunity adds to the vitality of the Nation's transportation system.

Jeffrey N. Shane,

Under Secretary of Transportation for Policy.

[FR Doc. E5–8306 Filed 1–4–06; 8:45 am]

BILLING CODE 4910–62–P

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Air Traffic Procedures Advisory Committee

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of public meeting.

SUMMARY: The FAA is issuing this notice to advise the public that a meeting of the Federal Aviation Air Traffic Procedures Advisory Committee (ATPAC) will be held to review present air traffic control procedures and practices for standardization, clarification, and upgrading of terminology and procedures.

DATES: The meeting will be held Tuesday, January 24, 2006 through Thursday, January 26, 2006, from 8 a.m. to 4:30 p.m. each day.

ADDRESSES: The meeting will be held at the National Aeronautics and Space Administration Aviation Safety Reporting System, 365 Moffett Park Drive, Sunnyvale, California 94089.

FOR FURTHER INFORMATION CONTACT: Ms. Nancy Kalinowski, Executive Director, ATPAC, System Operations Airspace and AIM, 800 Independence Avenue SW., Washington, DC 20591, telephone (202) 267–9205.

SUPPLEMENTARY INFORMATION: Pursuant to Section 10(a)(2) of the Federal Advisory Committee Act (Pub. L. 92–463, 5 U.S.C. App. 2), notice is hereby given of a meeting of the ATPAC to be held Tuesday, January 24, 2006 through Thursday, January 26, 2006, from 8 a.m. to 4:30 p.m. each day.

The agenda for this meeting will cover: a continuation of the Committee's review of present air traffic control procedures and practices for standardization, clarification, and upgrading of terminology and procedures. It will also include:

1. Approval of Minutes.
2. Submission and Discussion of Areas of Concern.
3. Discussion of Potential Safety Items.
4. Report from Executive Director.
5. Items of Interest.
6. Discussion and agreement of location and dates for subsequent meetings.

Attendance is open to the interested public but limited to space available. With the approval of the Chairperson, members of the public may present oral statements at the meeting. Persons desiring to attend and persons desiring to present oral statement should notify the person listed above not later than January 18, 2006. The next quarterly meeting of the FAA ATPAC is planned to be held from April 24–26, 2006, in Washington, DC.

Any member of the public may present a written statement to the Committee at any time at the address given above.

Issued in Washington, DC, on December 30, 2005.

Nancy B. Kalinowski,

Executive Director, Air Traffic Procedures Advisory Committee.

[FR Doc. E5–8314 Filed 1–4–06; 8:45 am]

BILLING CODE 4910–13–P

DEPARTMENT OF TRANSPORTATION

Federal Motor Carrier Safety Administration

[Docket Nos. FMCSA–99–5748, FMCSA–99–6156, FMCSA–2001–9258, FMCSA–2003–16241]

Qualification of Drivers; Exemption Applications; Vision

AGENCY: Federal Motor Carrier Safety Administration (FMCSA), DOT.

ACTION: Notice of renewal of exemption; request for comments.

SUMMARY: FMCSA announces its decision to renew the exemptions from the vision requirement in the Federal Motor Carrier Safety Regulations for 13 individuals. FMCSA has statutory authority to exempt individuals from vision standards if the exemptions granted will not compromise safety. The agency has concluded that granting these exemptions will provide a level of safety that will be equivalent to, or greater than, the level of safety maintained without the exemptions for these commercial motor vehicle (CMV) drivers.

DATES: This decision is effective January 3, 2006. Comments must be received on or before February 6, 2006.

ADDRESSES: You may submit comments by any of the following methods. Please label your comments with DOT DMS Docket Numbers FMCSA–99–5748, FMCSA–99–6156, FMCSA–2001–9258, or FMCSA–2003–16241.

- Web site: *http://dms.dot.gov.* Follow the instructions for submitting comments on the DOT electronic docket site.
- Fax: 1–202–493–2251.
- Mail: Docket Management Facility; U.S. Department of Transportation, 400 Seventh Street, SW., Nassif Building, Room PL–401, Washington, DC 20590–0001.
- Hand Delivery: Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

All submissions must include the agency name and docket number for this notice. Note that all comments received will be posted without change to *http://dms.dot.gov*, including any personal information provided. To read background documents or comments received, go to *http://dms.dot.gov* or to Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

QUESTION 9: What is the federal budget for bridge inspection and repair?

ANSWER: Federal Highway Bridge Program (HBP) funds are available for use by the States to support their bridge inspection, repair, replacement, and preservation programs. In fiscal year 2007, nearly $4 billion was apportioned among the States through the HBP. HBP apportionment data for all years is available at http://www.fhwa.dot.gov/legsregs/directives/notices.htm.

Other Federal-aid funds are also available and utilized for bridge activities. Since 2002, States have obligated more than $5 billion per year from various Federal-aid funding categories to bridge construction and preservation.

QUESTION 10: Do bridge inspectors inspect railroad bridges?

ANSWER: Privately owned commercial railroad bridges are not legally mandated to adhere to the NBIS requirements; however, many such bridges that also carry highways on public roads are being inspected in accordance with the NBIS.

The Federal Railroad Administration has issued a Policy Statement on the Safety of Railroad Bridges, with guidelines that are included in the Federal Track Safety Standards, **49 CFR 213, Appendix C**. These guidelines reflect the current railroad industry practices for inspection and management of railroad bridges.

QUESTION 11: Do bridge inspectors only inspect public bridges or do they inspect private bridges as well?

ANSWER: Privately owned bridges, including commercial railroad bridges and some international crossings, are not legally mandated to adhere to the NBIS requirements; however, many privately owned bridges on public roads are being inspected in accordance with the NBIS.

While 23 U.S.C. 151 states that the NBIS are for all highway bridges, FHWA has no legal authority to require private bridge owners to inspect and maintain their bridges. However, FHWA strongly encourages private bridge owners to follow the NBIS as the standard for inspecting their highway bridges. Where a privately owned bridge carries a public road, States should encourage the private bridge owner to inspect their bridge in accordance with the NBIS or reroute their public road.

ACEC

AMERICAN COUNCIL OF ENGINEERING COMPANIES

Testimony of Ray McCabe, PE,
HNTB Senior Vice President and National Director of Bridges and Tunnels
Before the Committee on Transportation and Infrastructure Subcommittee on Highways and Transit

Hearing on Structurally Deficient Bridges in the United States
October 23, 2007

Mr. Chairman and members of the committee, good afternoon. I am Ray McCabe, National Director of Bridge and Tunnel Design for HNTB. HNTB is one of the nation's leading engineering and architecture firms, with particular expertise in the planning and design of transportation infrastructure. I am a licensed professional engineer with over 30 years of experience in bridge planning, design and inspection of all bridge types. I have been involved in designing some of the nation's most significant bridges and have incorporated the latest technologies when appropriate.

HNTB is also a member of ACEC, the American Council of Engineering Companies, the business association of America's engineering industry representing over 5,500 member firms across the country. On behalf of ACEC and the industry, we appreciate the opportunity to testify before you today to discuss issues that contribute to bridge safety.

Bridges are the vital link allowing our transportation system to operate seamlessly across the country. Over half of our nation's bridges were built prior to 1964. Of the 600,000 public road bridges in the country, 74,000, roughly 12 percent, are classified as

structurally deficient. While this percentage has declined since the early 90's, progress has been slow and the magnitude of structurally deficient bridges is still clearly unacceptable even understanding that deficient does not imply unsafe.

The I-35 bridge collapse in Minneapolis was a national tragedy and awake up call on how we invest in our nation's bridges. While we do not know the cause of the I-35 bridge collapse in Minneapolis, we do know that the bridge was inspected according to federal standards. The engineering community anxiously awaits the findings of the NTSB to determine what corrections need to be made to our design , construction, inspection and maintenance practices.

Clearly, we need to make improvements to the bridge inspection program. Improving inspection procedures and techniques will allow us to better allocate available resources. However, it is important to remember that the information gathered from inspections must be applied to a well funded and focused program of bridge repair and replacement to prevent future disasters.

Maintaining our nation's bridges in a cost-effective manner and ultimately ensuring the safety of the people who travel them requires adequate funding combined with three components:

1. Improvements to the bridge inspection and ratings system.

The National Bridge Inspection Standards enacted in 1971 have served us extremely well. FHWA has diligently updated the standards to meet changing issues, needs and technology. Nonetheless, we know that the process is not perfect. Bridge inspections are generally visual which leads to subjective determinations of bridge conditions. An FHWA study indicated that "in depth inspections" are unlikely to identify many of the specific defects for which they are prescribed. The study found that less than 8% of the inspections successfully located weld cracks and other implanted defects in test bridges. Furthermore the study revealed that inspection ratings were highly variable and dependent on such things as; bridge inspectors' condition and training, inspection site conditions and accessibility, structure complexity and available funding. Many factors go into the calculation for sufficiency rating and thus a bridge that is rated structurally deficient may still be completely safe. Visual inspection practices must be supported by rigorous training, certification and quality assurance programs, and supplemented with testing techniques to ensure reliable results. Additionally, the emerging field of Structure Health Monitoring holds much promise for real-time evaluation of structures and objective evaluation of bridge conditions. Providing more quantitative data to bridge program managers enables them to more accurately rate bridges which will allow states to effectively allocate bridge rehabilitation dollars.

2. A dedicated methodology to allocate funding for structurally deficient bridges.

More money is a necessary part of the solution. However, any money targeted to fix our nation's structurally deficient bridges needs to be spent based on safety and prioritized

using a rational approach. Funding must be established based on accurate and consistent data, used strategically and stretched over as many deficient bridges as practical. This can be accomplished only by prioritizing our bridges and the individual repairs necessary to advance the most critical bridges out of the deficient category. As indicated earlier, improved inspection techniques will facilitate this approach. Such a system may have focused more resources on non-redundant welded bridges. These bridges must be given special attention because we know that non-redundant bridges pose a high risk of sudden bridge collapse from failure of an individual member. We have the technology to analyze failure scenarios and use the resulting data to determine bridge inspection methodology and retrofit techniques to reduce risk of bridge collapse.

3. Apply advanced technologies, techniques and materials.

New bridge designs and rehabilitation of existing bridges must make full use of innovative technologies and more durable materials. Resiliency is the key. Today's bridges need to diffuse loads and absorb stresses more effectively. They need to be able to withstand abrupt forces more readily and with less resultant damage. We need to incorporate high-performance concretes and steel into new spans and into structural renovations. Innovative rapid construction techniques should also be considered to minimize inconvenience to the traveling public.

The probability of a bridge failure is extremely low, but it is not zero. It should be, except for failure due to an extreme event. The way to insure the safety of our nation's aging bridge infrastructure is not just additional funding or rigorous inspection or

advanced technologies. It is all three put to concerted use. Let's not wait for the next failure.

Thank you for the opportunity to provide testimony. I look forward to taking your questions.

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Testimony of

The American Society of Civil Engineers

Before the

House Committee on Transportation and Infrastructure

on

Highway Bridge Inspections

October 23, 2007

Testimony of
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Chairman DeFazio, Congressman Duncan and Members of the Committee:

Good afternoon. I am Glenn Washer, PhD., P.E., past chair of the Committee on Bridge Management, Inspection and Rehabilitation of the American Society of Civil Engineers (ASCE)*, and Assistant Professor, at the University of Missouri – Columbia. I am a licensed Professional Engineer in Virginia. Previously, I have served as the director of the FHWA Nondestructive Evaluation (NDE) program at the Turner Fairbank Research Center (TFHRC). I currently teach and conduct research related to the development of nondestructive evaluation technologies. My research sponsors include the Departments of Transportation of Missouri, Texas, New York State and Tennessee, the University Transportation Center (UTC) at Rolla, the National Cooperative Highway Research Program (NCHRP) and NASA.

Let me start by thanking you for holding this hearing. As someone who has worked in this field for many years, I can say that there are few infrastructure issues of greater importance to Americans today than bridge safety, and I am pleased to discuss the role of nondestructive evaluation in the inspection process that helps ensure that safety.

I am pleased to appear today to be able to lend ASCE's expertise on the issue of bridge inspections and Nondestructive Evaluation of bridges.

I. Bridge Inspection Program

The National Bridge Inspection Standards (NBIS), in place since the early 1970s, require biennial safety inspections for bridges in excess of 20 feet in total length located on public roads. These inspections are to be performed by qualified inspectors. Structures with advanced deterioration or other conditions warranting closer monitoring are to be inspected more frequently. Certain types of structures in very good condition may receive an exemption from the 2-year inspection cycle. These structures may be inspected once every 4 years. Qualification for this extended inspection cycle is reevaluated depending on the conditions of the bridge.

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* ASCE, founded in 1852, is the country's oldest national civil engineering organization. It represents more than 140,000 civil engineers in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE is a 501(c) (3) non-profit educational and professional society.

Approximately 83 percent of bridges are inspected once every 2 years, 12 percent are inspected annually, and 5 percent are inspected on a 4-year cycle.

Information is collected documenting the conditions and composition of the structures. Baseline composition information is collected describing the functional characteristics, descriptions and location information, geometric data, ownership and maintenance responsibilities, and other information. This information permits characterization of the system of bridges on a national level and permits classification of the bridges. Safety, the primary purpose of the program, is ensured through periodic hands-on inspections and ratings of the primary components of the bridge, such as the deck, superstructure, and substructure. This classification and condition information is maintained in the National Bridge Inventory (NBI) database maintained by FHWA. This database represents the most comprehensive source of information on bridges throughout the United States.

Two documents, the American Association of State Highway and Transportation Officials' (AASHTO) *Manual for Condition Evaluation of Bridges* and the Federal Highway Administration's (FHWA) *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, provide guidelines for rating and documenting the condition and general attributes of bridges and define the scope of bridge inspections. Standard condition evaluations are documented for individual bridge components as well as ratings for the functional aspects of the bridge. These ratings are weighted and combined into an overall Sufficiency Rating for the bridge on a 0-100 scale. These ratings can be used to make general observations on the condition of a bridge or an inventory of bridges.

The factors considered in determining a sufficiency rating are: S1- Structural Adequacy and Safety (55% maximum), S2- Serviceability and Functional Obsolescence (30% maximum), S3- Essentiality for Public Use (15% maximum), and S4- Special Reductions (detour length, traffic safety features, and structure type--13% maximum).

In addition to the sufficiency rating, these documents provide the following criteria to define a bridge as structurally deficient or functionally obsolete, which triggers the need for remedial action.

Structurally Deficient – A structurally deficient (SD) bridge may be restricted to light vehicles because of its deteriorated structural components. While not necessarily unsafe, these bridges must have limits for speed and weight, and are approaching the condition where replacement or rehabilitation will be necessary. A bridge is structurally deficient if its deck, superstructure, or substructure is rated less than or equal to 4 (poor) or if the overall structure evaluation for load capacity or waterway adequacy is less than or equal to 2 (critical). Note a bridge's structural condition is given a rating between 9 (excellent) and 0 (representing a failed condition). In a worse case scenario, a structurally deficient bridge may be closed to all traffic.

Functionally Obsolete – A bridge that is functionally obsolete (FO) is safe to carry traffic but has less than the desirable geometric conditions required by current standards. A bridge is functionally obsolete if the deck geometry, underclearances, approach roadway alignment, overall structural evaluation for load capacity, or waterway adequacy is rated less than or equal

to 3 (serious). A functionally obsolete bridge has older design features and may not safely accommodate current traffic volumes, vehicle sizes, and vehicle weights. These restrictions not only contribute to traffic congestion, but also pose such major inconveniences as lengthy detours for school buses or emergency vehicles.

Structural Capacity –Components of bridges are structurally load rated at inventory and operating levels of capacity. The inventory rating level generally corresponds to the design level of stresses but reflects the present bridge and material conditions with regard to deterioration and loss of section. Load ratings based on the inventory level allow comparisons with the capacities for new structures. The inventory level results in a live load which can safely utilize an existing structure for an indefinite period of time. The operating rating level generally describes the maximum permissible live load to which the bridge may be subjected. This is intended to tie into permits for infrequent passage of overweight vehicles. Allowing unlimited numbers of vehicles to use a bridge at the operating level may shorten the life of the bridge.

Inspection Frequency

In the U.S. today, biennial inspection intervals are equally applied to the entire bridge inventory, with some exceptions, and may not be appropriate for specific bridges. For example, recently constructed bridges typically experience few problems during their first decade of service. Under the present requirements, these bridges can have the same inspection frequency as a 50 year old bridge that is reaching the end of its service life, and may face severe and rapid modes of deterioration. In the case of bridges with fracture-critical elements, elements who's failure could result in structural collapse, newer bridges with improved fabrication processes and designs intended to mitigate the effects of fatigue are inspected on the same interval as older bridges that do not share these characteristics. In many cases, these structures may not provide an equal level of risk.

A more rational approach to determining the appropriate inspection intervals for bridges would consider the design, details, materials, age and loading of specific bridges. There is a growing consensus that inspection intervals could be optimized toward meeting the goal of improving the safety and maintenance of highway bridges. A recent scanning tour of bridge evaluation quality assurance practices in Europe found that longer inspection intervals were normal, extending the inspection intervals to 6 years in some cases. However, in general these inspections were analogous to in-depth inspections in the U.S. system, in which there is an arms-reach inspection of the bridge that may include materials sampling and the application of NDE. A more detailed inspection conducted less frequently may have a positive impact on the overall safety and maintenance of bridges in the U.S., allowing for broader application of NDE technologies and a better understanding of the condition of individual bridges.

A longer inspection frequency could allow for the better utilization of resources by providing a platform for more in-depth inspections utilizing a broader array of NDE and other assessment technologies. It is worth considering the movement toward Risk-Based Inspection (RBI) for other industries. In RBI, the modes of degradation for a machine or component are identified. The probability of the degradation and the consequences of that degradation are considered in a risk assessment that is used to prioritize inspections, establish inspection intervals, and determine the scope of the inspection. In this manner, inspection efforts are focused on areas of highest

risk, allowing more time and resources to be dedicated. Obviously, highway bridges present some unique challenges in terms of the variable designs employed, varying construction practices, and complex deterioration characteristics. The development of more rational, possibly risk-based inspection process should be further evaluated, and may be a suitable topic for future research and development.

Bridge Engineers and Bridge Inspectors:

Bridge inspection services should not be considered a commodity. Currently, NBIS regulations do not require bridge inspectors to be Professional Engineers, but do require individuals responsible for load rating the bridges to be Professional Engineers. ASCE believes that non-licensed bridge inspectors and technicians may be used for routine inspection procedures and records, but the pre-inspection evaluation, the actual inspection, ratings, and condition evaluations should be performed by licensed Professional Engineers experienced in bridge design and inspection. They should have the expertise to know the load paths, critical members, fatigue prone details, and past potential areas of distress in the particular type of structure being inspected. They must evaluate not only the condition of individual bridge components, but how the components fit into and affect the load paths of the entire structure. The bridge engineer may have to make immediate decisions to close a lane, close an entire bridge, or to take trucks off a bridge to protect the public safety.

III. Nondestructive Evaluation of Bridges

Nondestructive evaluation (NDE) technologies describe a class of technologies intended to characterize the condition of materials, structures or components without causing damage. Visual inspection is the most common form of NDE. More advanced NDE technologies frequently depend on the characterization of waves propagating within the materials to infer the properties of the material or detect the existence of anomalies. A familiar example to most people is a medical sonogram, which utilizes acoustic waves launched from a transducer on the surface of the skin to assess conditions within the body, for example, the existence and characteristics of a fetus in the womb of a pregnant woman. Figure 1 shows such a medical sonogram of a fetus. It is important to note that the image is an indirect measurement, in that the image is created from the characteristics of the acoustic waves, which have traveled through a portion of the body, have been reflected from the fetus and subsequently detected at the surface of the skin. It's an interpretation of these waves that a fetus exists and what size and shape it might be. Other factors, such as a knowledge that

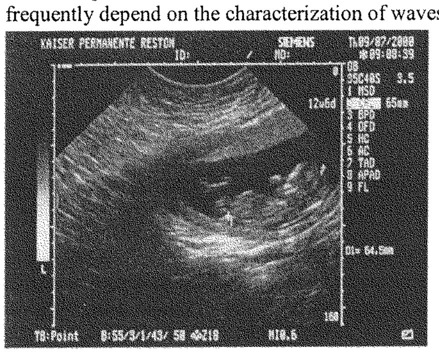


Figure 1. Medical sonogram of a fetus in the womb.

the women is pregnant or the appearance of what could be a beating heart, contribute to the assessment that this image is of a fetus, and not of a tumor or other anomaly in the body. Other features within the body such as internal organs can obscure the image, or create an environment where misinterpretation occurs. The single fetus in Figure 1, for example, was later determined to actually be twins, the second fetus having gone undetected.

In a manner similar to a medical sonogram, acoustic waves can be utilized to detect subsurface anomalies in solid materials such as bridge members. An acoustic wave can be launched into a member and will be reflected from internal features that may exist such as a crack or embedded void, and the boundaries of the material. This wave can then be detected later in time, and analysis of the travel time, size, shape and frequency of the detected waves interpreted by trained personnel to infer if a flaw exists and if so, estimate its size and shape. However this is not a direct measurement of its size and shape, and as such there is always a role of interpretation and engineering judgment involved in assessing what factors and material characteristics have affected the properties of the detected wave, and if the indications observed represent a flaw or may be some irrelevant indication.

The technique of using acoustic waves launched into metals to detect and characterize flaws is termed Ultrasonic Testing (UT), and is employed in a broad range of industries for the nondestructive evaluation of steel members, engine components, pipelines etc. For highway bridges, it is commonly employed in the fabrication process for the quality assurance of welds. For in-service bridges, it is common practice to utilize this method for the detection of cracks in bridge pins, and to a much lesser extent for the detection of fatigue cracking. A survey published by the FHWA in 2001 indicated that 81% of States responding to the survey utilized this technique for bridge inspection. Though the extent of that use is not fully known, it is not common as part of the initial bridge inspection but rather is utilized to address a specific component such as a bridge pin, or to address a known problem area during a special inspection.

Ultrasonic testing provides a useful analogy for describing in general terms characteristics of many NDE technologies. A transducer such as shown in figure 2A is placed on the surface of the material. This transducer launches a wave that transmits into the material, and is reflected by the boundaries of the material and internal flaws, if they exist. The reflected wave itself appears on an oscilloscope screen as shown in figure 2B. The transducer is scanned over the surface of the material to search for anomalies in the received signal, known as an "indication," that may correspond to a flaw. If such a signal is found, it is analyzed to determine if the indication is likely to arise from a flaw in the material and if so, to estimate the size and shape of the flaw. The development of powerful, portable computing resources has allowed for the responses that occur during the scanning process to be integrated into a spatial image that shows specific characteristics of the wave, for example its amplitude. Such an image developed from the acoustic response of embedded flaws in a weld is shown in figure 2C, and a radiographic image of the flaws is shown in figure 2D. As the figure indicates, both radiography and ultrasonic testing has the capability of revealing subsurface flaws that are typically unavailable for visual inspection, and can assist in estimating the size, shape and location of the flaw. NDE methods such as these can provide powerful tools that increase the ability to understand the condition of structures and detect deterioration in its early stages, such that action can be taken to improve the safety and maintenance of bridges.

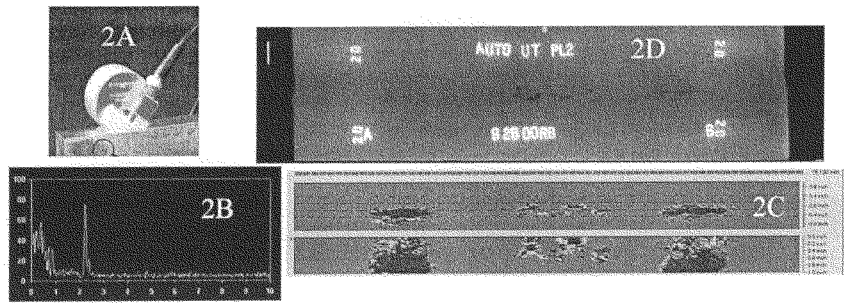


Figure 2. NDE data from ultrasonic and radiographic testing. 1A shows a typical ultrasonic transducer; 1B shows a reflection from subsurface flaws; 2C is an image developed from ultrasonic test results; 1D is a radiograph of flaws in a weld . (*FHWA Turner Fairbank Highway Research Center*)

The use of wave phenomena for nondestructive evaluation can be sorted into two general categories; those involving the interpretation of electromagnetic waves and those involving the interpretation of acoustic waves. Generally, these methods utilize the characteristics of wave propagating within or from a material under test to interpret if a flaw exists, or in some cases, to characterize strength-related properties of the material. A third class of related technologies, such as using strain gages to evaluate structural behavior, are in general health monitoring techniques, which may or may not include nondestructive evaluation technologies as elements of the overall systems.

Electromagnetic wave methods include such technologies as ground penetrating radar (GPR), which launches a high-frequency electromagnetic wave into a concrete structures and interprets reflections from internal features, such as delaminated concrete, in a manner analogous to ultrasonic testing. This method has shown to be useful for estimating the areas of concrete deck that may require maintenance or repair, though results have been variable. Other EM methods include radiography, eddy current testing, magnetic particle testing, microwaves, infrared thermography and others.

Acoustic wave methods include a broad variety of technique for the nondestructive evaluation of steel and concrete. Techniques that would fall generally in this category include ultrasonic testing, acoustic emissions, impact echo, impact velocity, vibration testing, chain drag and sounding, among others.

NDE Technologies

The following section lists a few of the NDE methods available for the condition assessment of highway bridges. Further descriptions of these methods can be found in Appendix A. The methods discussed are primarily those applied for superstructures and decks for the condition assessment of existing structures. Additional NDE technologies that may play a role in the quality assurance of construction practices have been omitted, although some of the techniques discussed are also used in that manner. The methods described are some of those widely available commercially, and it should be noted that a number of variations of the general techniques exist. First, NDE technologies for concrete are discussed, followed by NDE

technologies of steel. A final section describes the use of nondestructive load rating of structures and health monitoring.

Concrete
Concrete is a heterogeneous material consisting of cement paste, aggregates and embedded reinforcing steel. The primary deterioration modes for this material are driven by the environment, with corrosion of the reinforcing steel and resulting delaminations and spalling being a widespread issue in superstructures, substructures and decks. A number of NDE tools are available for assessing the condition of concrete bridge components. Methods for the detection of subsurface deterioration include:

- Sounding
- Impact Echo
- Ground penetrating radar (GPR)
- Infrared Thermography

Methods for detecting subsurface voids and other defects include:

- Radiography
- Ultrasonic Pulse Velocity
- Impact Echo

There are also a number of tools and instruments that can be used to determine if corrosion is occurring in the embedded reinforcing steel, including half-cell potential measurements, among others.

Steel Bridges
NDE technologies for steel bridges are focused largely on the detection of flaws, usually fatigue cracks, that may develop as a result of in-service loading. Methods vary in that some methods allow only for the detection of flaws, and are limited in their ability to measure fully the extent of the flaw. These methods generally allow for the detection of flaws that are surface-breaking and in areas available for visual observation. These methods include:

- Dye Penetrant
- Magnetic Particle
- Eddy Current

The ultrasonic testing method described previously has the advantage of being capable of extending its use to areas that may be hidden from view, and flaws do not need to be surface-breaking to be detected. This technology may also be used to quantify the effects of corrosion. Acoustic emissions testing can also be employed on steel bridges to detect and/or monitor fatigue cracking. Radiography can also be employed for detecting flaws in steel bridges, though it is primarily used during fabrication of bridges due to operational constraints.

Nondestructive Load Rating and Health Monitoring
Nondestructive load rating describes a process for determining the field performance of a bridge through a series of controlled tests that measure bridge response to applied loads. This approach may be used to define a limit load for a bridge, to confirm load ratings, or to better define structural behavior. The method generally involves applying sensors such as strain gages and deflection sensors to a bridge, and then loading the bridge with known loads and evaluating response. Analytical modeling of bridge behavior is generally a component of this process.

Health monitoring of bridges can be generally defined as monitoring bridge behavior over time. Sensors such as strain gages, tilt meters, accelerometers, and variable differential transformers are among those used for this purpose. There are a number of systems that can be used to monitor the bridge to provide real time data and alert the owner of such things as failure of a load carrying member, excessive rotation or displacement of an element, overload in a member or scour around a bridge pier. The type of information provided is typically very specific and provides data on isolated areas or members of the bridge. Monitoring systems routinely need to be verified and maintained, and typically do not eliminate the need for inspections since only isolated areas are examined. Health monitoring systems that are global in nature have been developed on an experimental basis, but there value within the context of bridge management and condition assessment has yet to be proven.

Role of NDE in Bridge Inspections
The role of NDE technologies beyond visual inspection has traditionally been limited in terms of the routine inspections of highway bridges, that is, the inspections that meet the minimum federal requirement. This is due in part to the reality that the data required to complete an NBIS-type inspection does not require NDE beyond visual inspection. However, that does not mean that NDE technologies are not used for the condition evaluation of bridges by State Departments of Transportation, which themselves have responsibility for the maintenance and operation of highway bridges. The use of sounding, for example, is widespread as a method to identify areas of deteriorated concrete and subsurface flaws, and is frequently part of a routine inspection.

It should be explained that the role of NDE in bridge inspection, and bridge inspections themselves, extend beyond ensuring the safety of bridges. The collection of data on the condition of bridges is an important component to their maintenance. NDE can play an important part of detecting deterioration in its embryonic stages, when remedial measures and repair can extend the useful life of a bridge and reduce the cost of future repair and rehabilitation. This may be well in advance of the deterioration progressing to a point where safety is a concern. Therefore, these technologies should be considered not only in terms of ensuring bridge safety, but also in terms of improving the process of bridge maintenance and management.

In terms of ensuring bridge safety, a number of NDE techniques can and do play a role in the inspection process. Using cracking in steel bridge members as an example, there are a number of technologies available with the capability to detect cracks in steel; a few have been described above. Ultrasonic testing has been discussed previously that uses acoustic waves to detect subsurface flaws. Other methods that are available to detect cracks include dye penetrant and magnetic particle. These two methods are well proven both for bridge inspection and in other industries. The advantage of these methods are that they are simple, there is widely available training and resources, and they can be highly portable. The primary disadvantages include that they are time consuming, very local in nature, highly inspector dependent, and require close access to the surface being tested.

More advanced methods for detecting cracks in steel include ultrasonic testing as previously discussed, and eddy current testing. Advantages of ultrasonic testing include that it has the capability to reveal subsurface flaws, it can be used to investigate areas that are not available for

visual inspection, and has increasing capabilities to produce spatial images of results that can aide in the interpretation of the data. This technique also has widely available training and resources, though training requirements are typically significantly greater than in the case of dye penetrant or magnetic particle, due to the complexity of the method.

All of these methods for detecting cracks in steel bridges face a similar and significant challenge. Although they have the capability to detect cracks beyond the capability of visual inspection, they are extremely time consuming and costly to employ on a wide-scale basis in the field. Using ultrasonic testing as an example, to detect flaws as shown in figure 1 requires detailed scanning over the area where a flaw is anticipated, and may require significant surface preparation, and interpretation of results can be complex. The transducers utilized for conducting this testing are typically on the order of 1 in. square. Scanning a bridge, which may be 2 thousand feet long and contain hundreds of potentially problematic details, can be operationally impractical. Even if the areas requiring scanning can be reduced through engineering knowledge and experience, the technique still requires a high level of access to the surface of the structure that may not be readily achievable. Further, the results of the testing are an indirect measurement, and as such rely heavily on the interpretation that can be highly complex. The occurrence of "false positives," that is flaws reported where none exist, can undermine confidence in the method.

A significant challenge to the application of NDE technologies for highway bridges is providing reliable, quantitative results under a variety of experimental conditions. Although the capability to detect certain types of defects or flaws may exist, the reliability of that process under real-world conditions must be established. This has proven difficult in a number of cases due to the challenging environment experienced during bridge inspections. Widely varying materials, designs and construction practices may lead to uncertainty in the results of NDE inspections. Because NDE technologies are in general indirect measurements, and sensitive to a variety of factors other than the specific flaw they are intended to characterize, results can often be uncertain and qualitative. Additionally, a variety of deterioration modes, mostly driven by the environment, may occur simultaneously and undermine efforts to detect certain flaws for which a method is intended. For example, cracking in steel may occur at the same location as severe corrosion, making the detection of cracking much more complex. A broader understanding is required of the complexity of bridge inspections and the application of NDE technologies as a part of those inspections.

An additional complication with NDE technologies in general is that these technologies are intended to detect and characterize flaws or material condition. The significance of a detected flaw requires engineering analysis to determine if the flaw has a detrimental impact of the behavior or durability of the structure, and if so, to also determine the appropriate remediation. This process is complicated if the NDE results include significant uncertainties.

It should be noted that despite these challenges, the role of NDE technologies in bridge inspection has been growing. Methods such as ultrasonic testing of bridge pins are in widespread use, as are magnetic particles testing, dye penetrant, impact echo and pulse velocity measurements, to name a few. These methods are frequently employed in the context of special inspections, where visual inspections have identified potentially problematic areas in need of

additional analysis and testing. Other methods, such as GPR, have found a role in evaluating bridge conditions on a system level, to qualitatively determine bridge decks in relatively better or worse conditions. New instrumentation for the nondestructive load rating of bridges, such as wireless sensors and laser measurement devices, has improved accessibility of these techniques and contributed to increased application. Continued efforts to develop and apply these innovative technologies is an important component of ensuring the long term safety and reliability of the nation's bridges and other infrastructure.

Research Needs
A primary challenge to the application of NDE technologies for the inspection of highway bridges is developing effective methods for implementation. Although these technologies may have the capability to detect certain flaws or anomalies, the reliability of the techniques to provide accurate, conclusive results remains a significant limitation in many cases. Research is required to establish which methods can provide data that is reliable, and produces results significantly beyond what could be accomplished with visual inspections such that the increased cost (beyond the cost of visual inspection) is justified. To date, this remains an elusive goal for many NDE technologies. Additionally, methodologies that will allow these technologies to be effectively applied within the context of bridge inspections, with consideration for the unique challenges associated with the environment and access limitation of bridges, are needed. The widely varying nature of materials, designs and construction make quantitative definition of the reliability of NDE techniques particularly complex for highway bridges. Investment in addressing reliability issues with NDE technologies, such as quantitative analysis of detection probabilities, could improve and broaden their application.

An important gap in research presently is effective methods for the condition assessment of prestressed and post-tensioned bridges. For these structures, prestressing strands or tendons that play a critical role in structural performance are embedded in concrete, such that they are unavailable for visual inspection. These tendons are highly susceptible to the effects of corrosion, and tendon failures have been experienced in the field. It should be noted that the construction of bridges with these design features began on a widespread basis in the 1960's, such that this population of bridges is just now reaching 50 years of age. New bridge designs, such as cable-stayed bridges, also utilize these strands within the main stays, sometimes embedded within a cementitous grout intended to provide corrosion protection. The resulting configuration presents limited access for inspection and evaluation of these critical components. The lack of effective methods for assessing the condition of the embedded steel is a significant gap in available technologies. The critical need for research and development to address this gap is urgent.

Education and Training
It should be recognized that a significant barrier to the effective development, application and implementation of NDE technologies is a lack of suitable education and training. These technologies typically require knowledge that is multi-disciplinary in nature, combining concepts and practices from physics, electrical engineering, mechanical engineering and materials science, among others. Typical training for Civil Engineers, in fact, engineers of any discipline, does not adequately address these topics in an integrated fashion as they are applied NDE technologies. Such education at the undergraduate and graduate level is needed to develop a foundation of

knowledge to support critical thinking and analysis, and develop engineers with adequate knowledge to effectively apply NDE technologies. Presently, the application and limitations of NDE technologies remains outside the expertise of the engineers that may rely on the technologies for critical decision making in the future.

Training in the use and application of NDE technologies as a part of undergraduate education for Civil Engineers is very rare. Likewise, durability and maintenance of structures is not a common topic for undergraduate education. Even though corrosion and its effects represent perhaps the most significant challenge to health of our infrastructure, study of corrosion science is essentially unknown in undergraduate civil engineering curriculum. Additional focus on training and education of the engineering community, such that a deeper understanding of the potential and limitations of NDE technologies is developed, should be explored. Increased education focused on the important areas of maintenance and preservation of infrastructure should also be considered key for developing engineering expertise and depth on a national level, and addressing the critical needs for maintaining the ageing infrastructure.

IV. ASCE's Public Policy Statements Regarding Bridges

Funding programs for transportation systems, i.e., federal aviation, highways, harbors, inland waterways, and mass transit as documented by the U.S. Department of Transportation, need to be increased, to provide orderly, predictable, and sufficient allocations to meet current and future demand. The Highway Trust Fund is in danger of insolvency (as other trust funds may be in the future) and must receive an immediate boost in revenue to ensure success of multi-modal transportation programs. In fact, the Office of Management and Budget estimates that in FY 2009 the Highway Account of the Highway Trust Fund will be in the red by as much as $4.3 billion.

The safety, functionality, and structural adequacy of bridges are key components necessary to support and ensure the safe, reliable, and efficient operation of transportation infrastructure and systems which provide mobility of people and the movement of goods and services. Federal policy establishes the minimum bridge safety program components necessary for both public and private bridges to ensure an adequate and economical program for the inspection, evaluation, maintenance, rehabilitation, and replacement of our nation's bridges.

Continued neglect and lack of adequate maintenance will ultimately result in higher annual life-cycle costs of bridges due to shortened service life. Therefore, investment to improve the condition and functionality of the nation's bridges will reduce the required investment in the future.

Bridge Safety
For the continued safety of the nation's bridges, ASCE advocates that a bridge safety program for both public and private bridges be established, fully funded, and consistently operated to upgrade or replace deficient bridges and to properly maintain all others. This program should preserve full functionality of all bridges to support the operation of safe, reliable and efficient transportation systems, and to allow these systems to be utilized to their full capacity. Such programs should include as a minimum:

- Regular programs of inspection and evaluation that incorporate state-of-the-art investigative and analytical techniques, especially of older bridges which were not designed and constructed to current design loading and geometric standards;
- Posting of weight and speed limits on deficient structures;
- Implementing and adequately funding regular system-wide maintenance programs that are the most cost-effective means of ensuring the safety and adequacy of existing bridges;
- Establishing a comprehensive program for prioritizing and adequately funding the replacement of functionally obsolete and structurally deficient bridges;
- Setting a national goal that fewer than 15% of the nation's bridges be classified as structurally deficient or functionally obsolete by 2010

Transportation Funding

Adequate revenues must be collected and allocated to maintain and improve the nation's transportation systems and to be consistent with the nation's environmental and energy conservation goals. A sustained source of revenue is essential to achieve these goals.

ASCE recommends that funding for transportation system improvements, associated operations, and maintenance be provided by a comprehensive program including:

- User fees such as motor fuel sales tax;
- User fee indexing to the Consumer Price Index (CPI);
- Appropriations from general treasury funds, issuance of revenue bonds, and tax- exempt financing at state and local levels;
- Trust funds or alternative reliable funding sources established at the local, state, and regional levels, including use of sales tax, impact fees, vehicle registration fees, toll revenues, and mileage-based user fees developed to augment allocations from federal trust funds, general treasuries funds, and bonds;
- Refinement of the federal budget process to establish a separate capital budget mechanism, similar to many state budgets, to separate long-term investment decisions from day-to-day operational costs;
- Public-private partnerships, state infrastructure banks, bonding, and other innovative financing mechanisms as appropriate for the leveraging of available transportation program dollars, but not in excess of, or as a means to supplant user fee increases;
- The maintenance of budgetary firewalls to eliminate the diversion of user revenues for non-transportation purposes, and continuing strong effort to reduce fuel tax evasion.

V. Conclusion

This testimony has attempted to provide some explanation of what NDE technologies are, and how they are applied within the context of highway bridge inspections. Limitations associated with the complex nature of bridges and their deterioration has been described. There exist tremendous potential to improve bridge safety and maintenance through the proper application and use of NDE technologies. However, there are limitations, many related to the ability of NDE methods to provide quantitative results that clearly provide improvements over the capabilities of visual inspection. There exist tremendous potential for NDE technologies to address the most significant inspection challenges faced in the long-term management of our nation's bridges, and additional research and development is critical to realizing that potential.

Several specific areas of research have been described as well as the important need to provide additional training and education in this unique area.

Successfully and efficiently addressing the nation's infrastructure issues, bridges and highways included, will require a long-term, comprehensive nationwide strategy—including identifying potential financing methods and investment requirements. For the safety and security of our families, and our nation, we can no longer afford to ignore this growing problem. We must demand leadership from our elected officials, because without action, aging infrastructure represents a growing threat to public health, safety, and welfare, as well as to the economic well-being of our nation.

Thank you, Mr. Chairman. That concludes my statement. I would be pleased to answer any questions that you may have.

# # #

Appendix A – NDE Technologies for Highway Bridges
The following section describes few of the NDE methods available for the condition assessment of highway bridges. The methods discussed are primarily those applied for superstructures and decks for the condition assessment of existing structures. Additional NDE technologies that may play a role in the quality assurance of construction practices have been omitted, although some of the techniques discussed are also used in that manner. The methods described are some of those widely available commercially, it should be noted that a number of variations of the general techniques exist. First, NDE technologies for concrete are discussed, followed by NDE technologies of steel. This is not intended to be a comprehensive list, but a sampling of some of the more common NDE technologies.

Sounding
This method consists of striking the surface of the concrete with a hammer and listening for tones that indicate deteriorated concrete. In many cases, this method is implemented using a series of chains dragged over the surface to achieve the same effect. In either case, this method has proven an invaluable tool to inspector for determining the extent of subsurface deterioration, which may not be visually observable. The application of this technique is widespread, due in part to its simplicity and low cost. The results of sounding may play a role in the inspector rating of a bridge component, contributing to the overall understanding of its condition.

Half – Cell Potential
This method consist of measuring the corrosion potential of embedded reinforcing steel to infer if active areas of corrosion are present. This method is widely available from consulting firms and within State Departments of Transportation, applied primarily to identify active corrosion in bridge decks.

Pulse-Velocity
Measuring the velocity of a pulse of ultrasonic energy (wave) propagating within concrete can be used to determine empirically the elastic properties of the material. This method is generally used to define the extent of damage in concrete, and is sometimes used to identify subsurface voids. A significant disadvantage faced in the application of this technique is that it generally requires access to two sides of the material under tests, limiting its practical application to cases where such access is achievable.

Impact-echo
The impact echo method is closely related in physics to the pulse velocity and sounding. The method is normally performed by impacting the surface of the concrete, and measuring the response to that impact with accelerometers or other suitable instrumentation.

The wave characteristics of the response, such as frequency and velocity, are interpreted to determine the thickness of a concrete deck, subsurface deterioration, or internal voids. A multitude of variations that generally fit this description have been developed that examine and interpret the response in different ways. An advantage to these techniques over the pulse-velocity approach is that they typically require access to only one surface of the material under test. Disadvantages include that the application of the techniques can be time consuming, and results can at times be inconclusive.

Ground Penetrating Radar (GPR)
GPR launches a high-frequency electromagnetic wave into a concrete structure and interprets reflections from internal features, such as delaminated concrete. This method has shown to be useful for estimating the areas of concrete deck that may require maintenance or repair, though results have been variable. This method is also useful for determining the locations of embedded metallic materials, such as reinforcing bars or ducts in post-tensioned bridges. A significant advantage to this approach is that GPR can be implemented from air-launched antennas, which allow for inspections of concrete decks to be conducted at highway speeds in some cases. A disadvantage of the method is that results can rely heavily on expert interpretation.

Infrared Thermography
Infrared thermography is method of analyzing the thermal transfer properties of a material. In concrete, for example, subsurface anomalies such as delaminations effect the rate of heat transfer through the material, which manifests as variations in the surface temperature resulting from diurnal temperature variations. An infrared camera can be used to develop an image of the surface of the material by measuring the rate at which electromagnetic energy is emitted from the material, which is highly sensitive to the temperature of the material. Figure 2 provides an example of an infrared image. In this image, subsurface targets embedded in concrete at depths of 1, 2, 3 and 5 inches are imaged using an infrared camera. The advantage of this technique is that it can be applied from some distance, such that direct access to the structure is not required. A primary value of this is the lack of traffic disruption that may be required to implement the technique. A significant disadvantage is that the method depends entirely on environmental conditions to function. The appropriate environmental conditions for conducting effective inspections is the topic of current research.

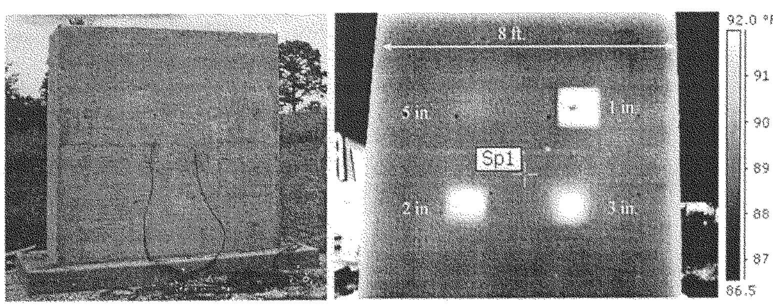


Figure 2. Infrared image of a 8 ft. x 8 ft. concrete block (shown on left) with targets embedded in concrete at depths of 1, 2, 3 and 5 inches. *(University of Missouri – Columbia)*

Radiography
Like a medical x-rays, images of the internals features in concrete bridges can be developed using linear accelerators or even isotopes in certain circumstances. The ability to penetrate significant thickness of concrete make this a viable technique for the detection of certain internal flaws, such as grout voids in post-tensioning ducts. Like a medical x-ray, photons radiating from

a tube or isotope are directed through a material and detected by a film or digital detector. The photons carry the legacy of the materials through which they have traveled. The photons are scattered more by highly dense materials then by materials of lower density. The resulting image is a two-dimensional map of the density variations in the materials under test. Density variations that result from flaws in the materials appear in the image and can be interpreted by a trained inspector. It should be noted that this technique can and is used for steel bridges as well as concrete bridges. Highly specialized training and safety procedures are required for implementation, making this method difficult and costly to apply in the field.

Steel Bridges

There are a multitude of NDE technologies available for steel bridges, primarily focused on the detection and characterization of cracks in steel. Most of the techniques available have been developed initially for other industries, such as manufacturing and aerospace. A few of the most widely available and utilized methods are described here.

Dye Penetrant

Dye penetrant is a relatively simple technique in which a dye applied to the surface of the steel is used to reveal the existence of a crack that may not be apparent to the naked eye. A developer is typically used to improve the contrast between the dye emerging from a crack and the surrounding area. While simple to use, the method is time consuming and requires extensive surface cleaning to be effective.

Magnetic Particle

Magnetic particle testing induces a magnetic field in the steel, and finely divided iron particles applied to the surface are attracted to field leaking from a crack. This method is widely applied in the fabrication of steel bridges, and can also be used in the field.

Ultrasonic Testing

Ultrasonic testing has been previously described, the method generally launches an acoustic wave into the steel, and reflection from internal features create reflections that are detected and subsequently analyzed.

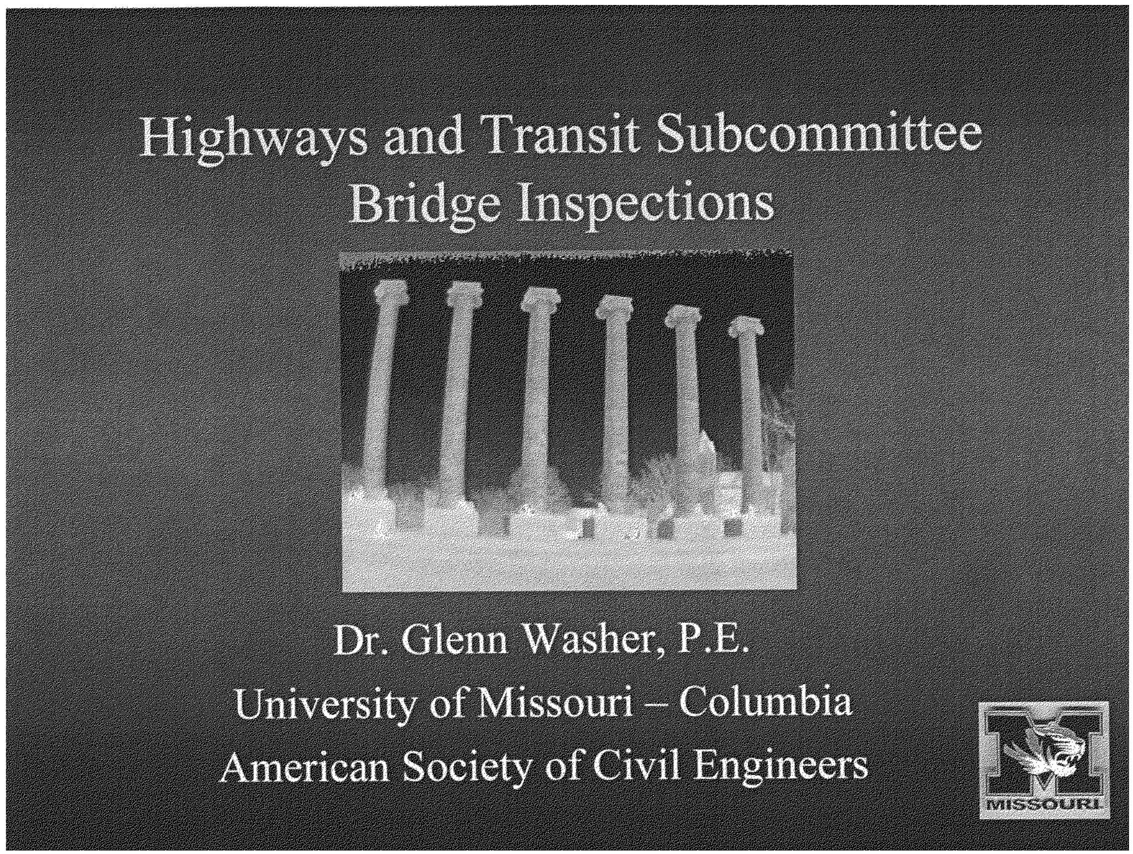
Eddy Current

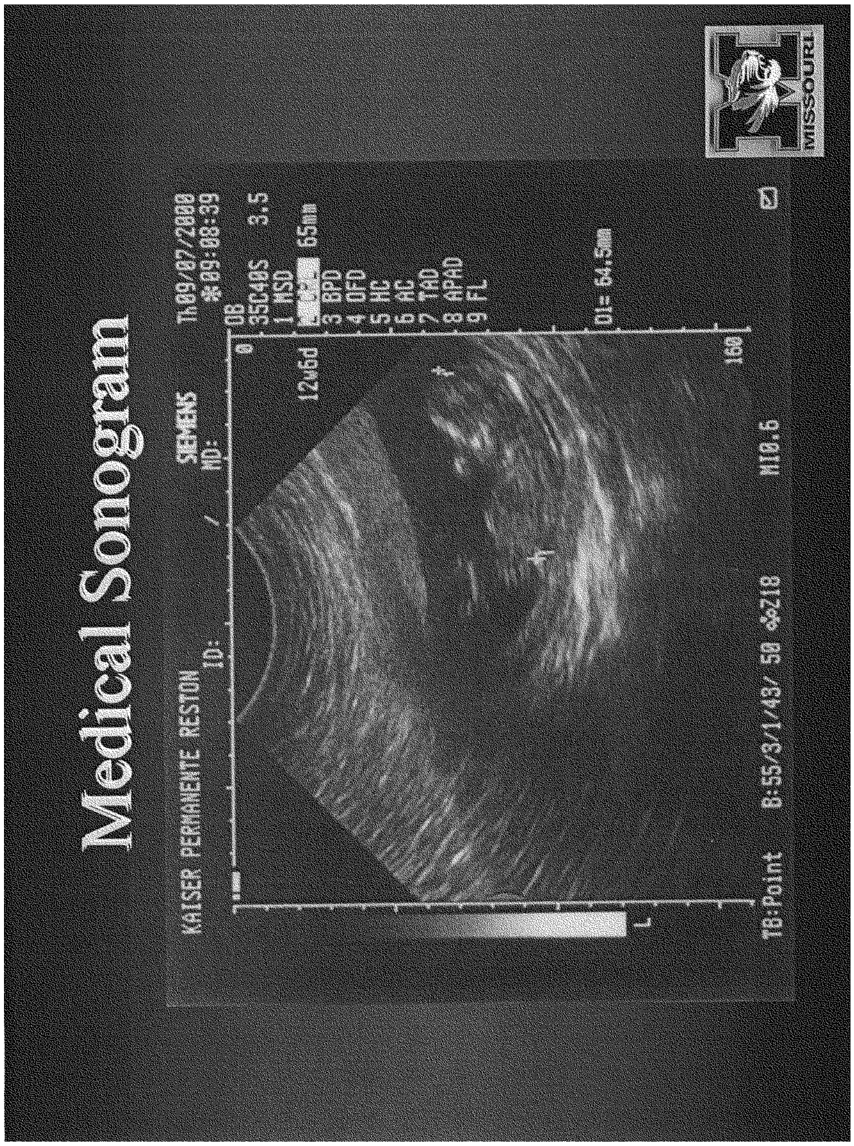
The eddy current method detects cracks by the monitoring the effects of a crack on the trajectories of induced electrical currents in the surface of the steel. The interpretation of results, however, can be complicated and operator dependant, especially in the bridge environment, where nonrelevant indications due to geometric effects are prevalent. The advantages of this technique include the ability to detect cracks beneath coatings, highly portable equipment and minimum surface preparation. New approaches to applying this technique include the ability to produce spatial images of results, which may support improved detection and evaluation capability. Several variations of this basic method are available.

Acoustic Emission Testing

Acoustic emission systems are intended to detect and monitor the energy released as a result of crack growth. The method is typically implemented by placing sensors at or near a location

where a crack is anticipated or known to exist, and monitoring for small acoustic waves released during crack growth. This method has been demonstrated to be effective for monitoring known cracks in steel bridges in some cases. In recent years, systems that monitor cables such as those in a cable-stayed bridges have been developed. These systems detected the sound energy released by a wire break, and several systems have been installed on major bridges in the US to monitor the rate of wire fractures.


Highways and Transit Subcommittee
Bridge Inspections
Dr. Glenn Washer, P.E.
University of Missouri – Columbia
American Society of Civil Engineers
MISSOURI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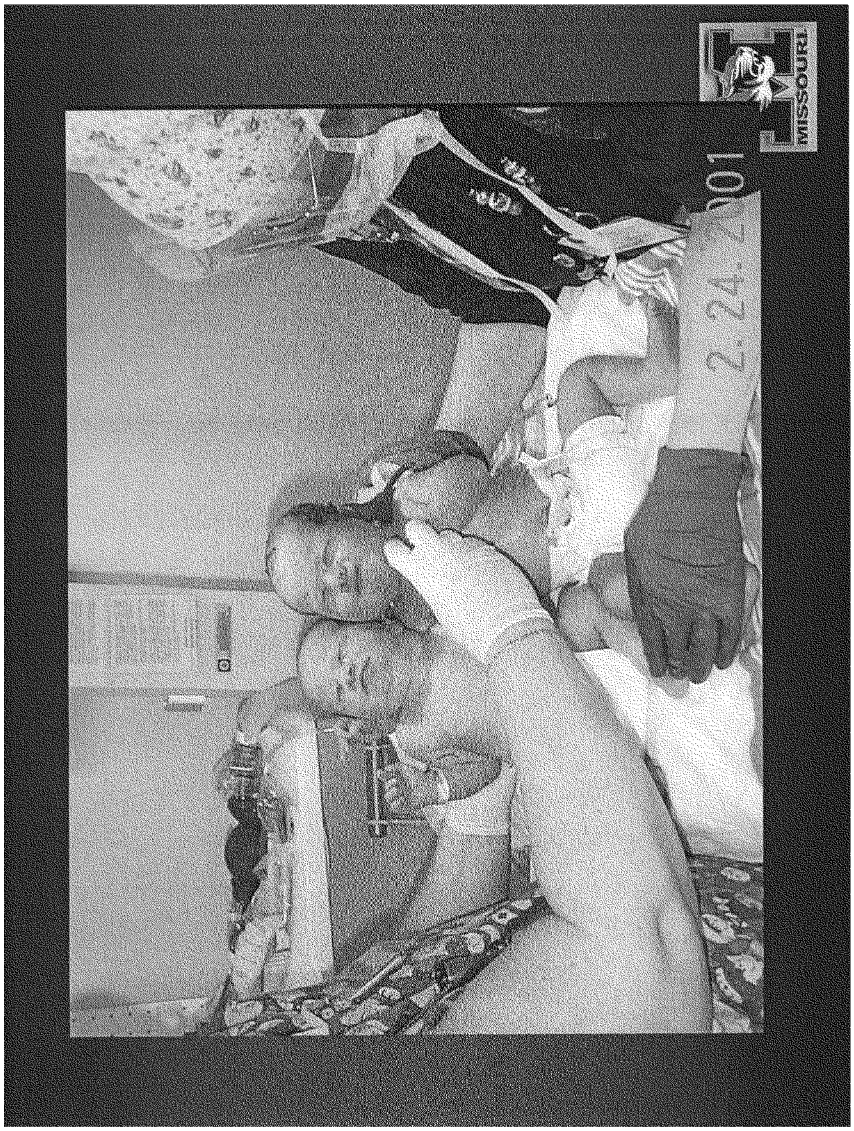
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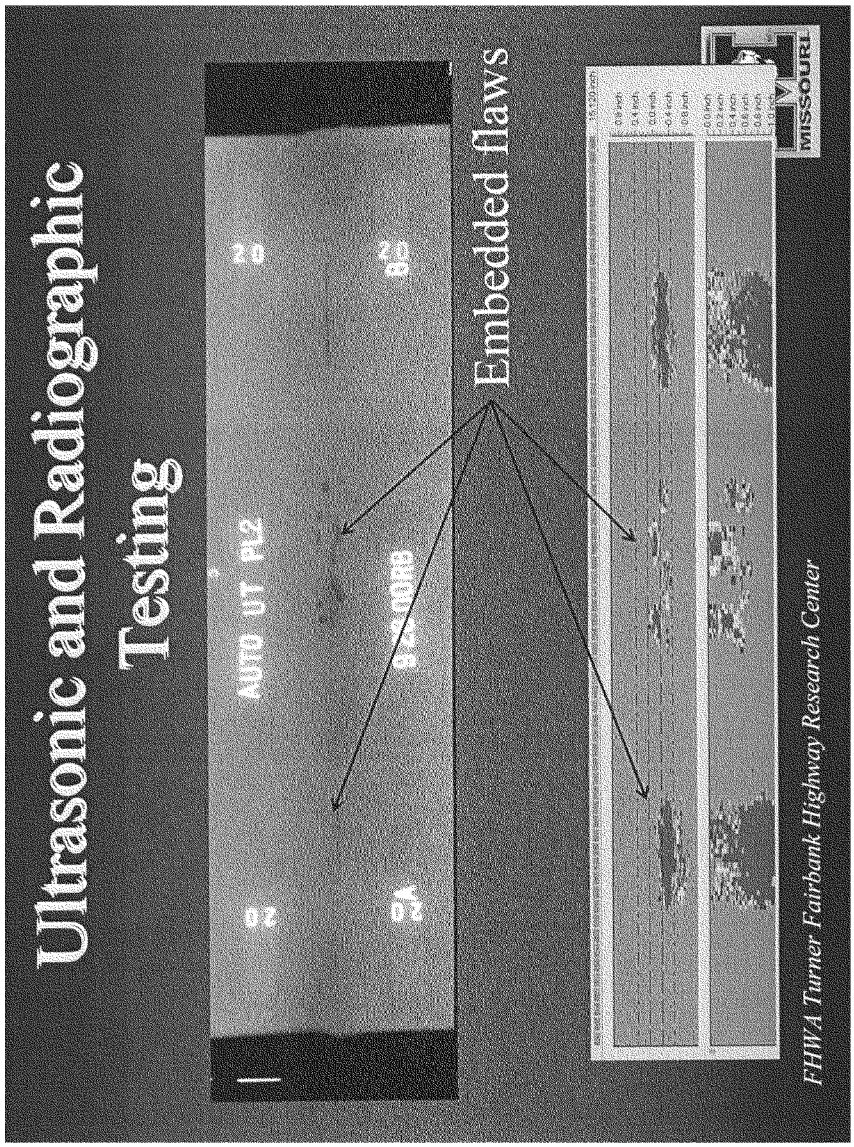
Ultrasonic and Radiographic Testing
Embedded flaws
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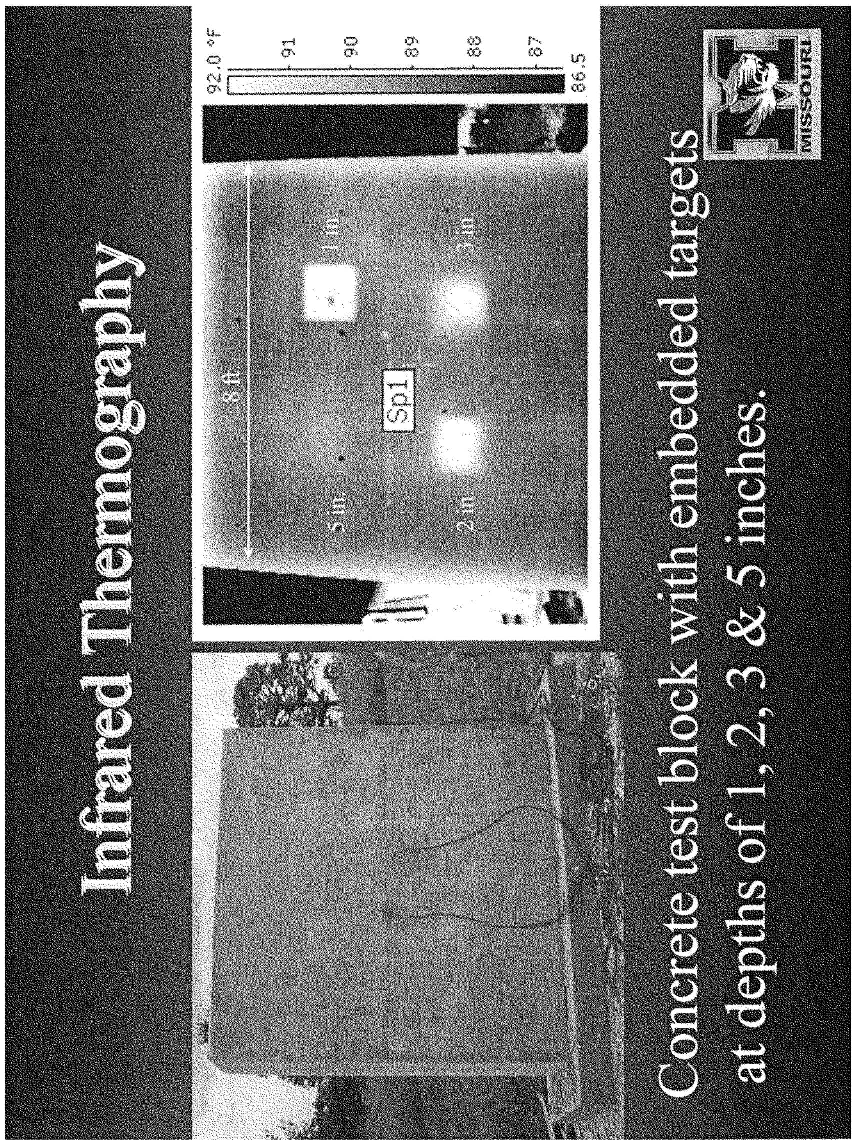
Infrared Thermography
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Concrete test block with embedded targets
at depths of 1, 2, 3 & 5 inches.
MISSOURI

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The Honorable Peter DeFazio
Chairman, Subcommittee on Highways and Transit
Washington, D.C. 20515

December 19, 2007

Dear Chairman DeFazio,

The attached document provides responses to questions included in your letter of November 19, 2007. Thank you for the opportunity to provide additional information regarding bridge inspection practices and standards in the United States. I hope that the information provided in these responses is helpful in your efforts to improve the safety of the highway infrastructure.

Please contact me if you have any questions or concerns. I may be reached at (573)884-0320 or by email at washerg@missouri.edu.

Sincerely,

Glenn A. Washer

Glenn A. Washer, Ph. D., P.E.
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Question 1. How do you believe the Federal Government would develop such an approach to bridge inspection?

The National Bridge Inspection Standards (NBIS) have provided the foundation for the development of bridge inspection systems throughout the U.S.. Although States have somewhat varying approaches to implementing the NBIS, the scheduling of inspections as required by the NBIS is a common element throughout. Additionally, the rating system for bridge components is mandated, such that specific information is provided in a specific format. To modify the approach to bridge inspection will require action through modifying the Code of Federal Regulations (CFR), as a result the Federal Government has a key role to play.

In regards to developing a risk-based, rational inspection program that allows for prioritizing inspection, there are two key elements required. First, a better understanding of the long-term performance of bridges is required to enable the assessment of deterioration timelines, and to better define the risks associated with specific modes of deterioration. Sound engineering judgment and experience can provide important input in this arena, and research such as the Long Term Bridge Performance Program can provide more systematic and quantifiable data. Research and development in the area of developing methodologies to consolidate and apply this knowledge to the characterization of risk for bridge systems is required.

Second, the capability of inspection methodologies, including the application of Nondestructive Evaluation (NDE) techniques as part of the inspection process, must be better defined, such that the ability to detect critical forms of deterioration is quantified. There exists a knowledge gap in the area, as the reliability of NDE techniques including visual inspection methods have been the subject of limited research in the bridge arena. As a result, the actual capabilities of bridge inspections are not well quantified, and research in this area will be required to provide the necessary understanding that would support a more reliable system of bridge inspection.

These two elements provide the foundation for a rational or risk-based method of determining the frequency and scope of inspections. It should be recognized that there is an interdependence between these elements, in that the frequency of inspections must consider: the scope of the inspection to be conducted; the ability of the inspection to detect and quantify specific forms of deterioration; and the rate at which that deterioration develops toward affecting the structural capacity and durability of the bridge. This is a significant departure from the present, calendar-based approach to bridge inspection. The development and implementation of a bridge inspection program based on this approach will require a significant investment in research, training and implementation strategies.

There have been some important steps taken in recent years in developing bridge management programs. However, the implementation of these programs at a State level has been uneven. Frequently, States consider the programs and methods involved to be too complex and time consuming to be relevant within their maintenance and inspection programs, which are focused on meeting the NBIS requirements. Even though the implementation of bridge management programs has been previously included as part of the NBIS, resistance at the State level has limited the implementation of these programs. Bridge management programs have been developed with the intention of forecasting funding needs on a system level, and as such, do not fully address the development of inspection criteria and procedures that will be required to successfully implement a risk-based inspection program. However, the integration of management systems within the context of a risk-based inspection process will be a necessary component of such a system, and the effectiveness of bridge management practices should be expected to improve.

In addition, there exists a need to better integrate the design, fabrication, construction, maintenance and inspection practices for highway bridges. Under the current paradigm, these functions are typically compartmentalized such that the inspection and maintenance of a bridge plays only a small role in the design and fabrication of bridges. A more holistic approach that integrates inspection criteria and methods into design and construction practices, and more closely integrates maintenance and inspection, should be considered an important goal. While this has been a long-stated goal for highway agencies, the realization of this goal has been elusive. For example, cable-stayed and post-tensioned bridges are being constructed at an increasing rate, even though it is widely recognized that critical elements in these structures are not available for inspection.

A concerted effort by the FHWA to develop a risk-based or rational inspection program will be required, and it should be anticipated that funding to support this effort at both the Federal and State level will likely be required to make such an effort successful. The priority of inspection, maintenance and preservation relative to new construction and re-construction must be elevated, such that more investment will be made in these processes.

Question 2. Would this be based on the risk or condition of individual bridge elements or the entire structure?
Such a system should be based on the risk for the entire structure, but this must integrate the risk of individual elements. Fracture critical elements in a bridge could dominate the risk assessment for that particular structure, as these elements have the potential ability to cause structural collapse. The reliability of the overall bridge system should be viewed as a weighted composite of the reliability of elements from which the system is constructed. Such assessments would help to focus and define the scope of inspections, identifying the most critical elements of the system to be assessed during the inspection process. Presently, bridges are assessed under the NBIS in terms of the overall condition of the deck, superstructure and substructure, three main components of a bridge.

Element-level inspections and risk assessments would improve the ability of the system to appropriately characterize bridge condition. Elements-level inspections are typically conducted to some extent as part of NBIS inspection, particularly in the context of determining maintenance requirements. However, on a national level, the application of element-level inspections is at best uneven. Some States, such as New York, essentially perform element-level inspections on all bridges, and then convert those results to meet a less stringent Federal Requirement. States utilizing certain bridge management programs may also conduct element level inspections. Other States assess elements through a series of inspector notes that provide information supporting the component rating provided to meet the requirements of the NBIS. On a national scale, there is inadequate systematic consistency in the element-level inspection process to effectively characterize this process. It would be expected that more element-focused inspection would be a component of a risk-based or rational bridge inspection process.

Question 3. Should there be some minimum time period for the inspection of all bridges?
It would seem that some form periodic inspections would be necessary to ensure safety and maintain the operational functions of bridges. Presently, a two year maximum time period between inspections, with some exceptions, is required by the NBIS. Under a revised system that institutes a risk-based approach and provides more flexibility to develop rational inspection frequency and scope, some maximum interval would still be required for practical purposes. This inspection could be very brief, to ensure that there are no gross structural movements, and to identify maintenance activities that may be required to preserve the health and operational capability of the structure. The inspection process could be developed such that the administrative burden of the current routine inspection process is reduced for these shorter-interval inspections, provided that there were adequate in-depth inspections conducted at a longer time intervals.

Sound engineering judgment could also be utilized to determine the appropriate frequency more specifically for particular bridges. A tiered approach, as discussed below, would include such shorter interval operational inspections as part of a revised inspection system.

The current proposed approach of setting a uniform, one-year inspection frequency for structurally deficient and fracture critical bridges is not likely to result in the most effective utilization of resources, nor does the biennial frequency set by the NBIS. More benefit would be derived from conducting less frequent but more thorough and targeted inspections, based on design, condition and risk, rather than conducting limited inspections more frequently.

Question 4. What about a tiered approach that employs routine inspections more frequently, while conducting in-depth inspection less frequently based on condition, age and design of the facility.
Such a system could have significant advantages over the present, time-based method of scheduling inspections. As documented in my testimony of October 23, 2007, I believe a more rational approach to determining the appropriate frequency of inspection could improve the overall safety of bridges by allowing better utilization of inspection resources. This was an approach that was found during the recent scanning tour of Europe sponsored by the FHWA, AASHTO and NCHRP entitled "Bridge Evaluation Quality Assurance." It was observed during this scanning tour that longer inspection intervals were normal, extending the inspection intervals to 6 years or even 9 years in some cases. However, in general these inspections were analogous to in-depth inspections in the U.S. system, in which there is an arms-reach inspection of the bridge that may include materials sampling and the application of NDE. Less comprehensive inspections were conducted during the time between these in-depth inspections. Training and certifications of inspectors were matched to the level of inspection they were expected to conduct, with a higher level of training and expertise involved in the more in-depth inspections. In some cases, training was also matched to the complexity of the bridge, with more complex and significant bridges having specialized inspectors.

A more detailed inspection conducted less frequently may have a positive impact on the overall safety and maintenance of bridges in the U.S., allowing for broader application of NDE technologies and a better understanding of the condition of individual bridges. The effective management of the bridge inventory could be improved, leading to better operational capacity, reduced maintenance cost and improved reliability of the system.

A significant issue with the present inspection system for routine inspection is that the minimum requirements for the inspection are met in a wide variety of ways. The rating system presently employed for rating bridge components is not adequate to provide for consistent inspection processes across the country. Research conducted by the FHWA in 2001(FHWA-RD-01-020- 021) has quantified this issue to some extent. These ratings need to be more quantitative in nature and include a consideration of risk. Additionally, quality control procedures and practices to ensure a more uniform application of inspection requirements across the country are needed to support improvements to inspection practices.

In conclusion, I believe there is a growing consensus in the bridge engineering community that bridge inspection practices and policies need to be improved and modernized, such that resources can be utilized more effectively and safety can be improved. Initial efforts to develop more rational approaches for the inspection of fracture critical bridges are currently underway in research projects being conducted by Dr. Robert Conner at Purdue University. Additional research on developing rational or risk-based inspection practices will certainly be required to effectively implement these concepts. Research programs such as FHWA's Long Term Bridge Performance Program can make important contributions in the arena. Research on improving inspection methodologies, including the application of NDE, is critically needed

to determine the capability and reliability of inspections. In this area in particular, the highway industry lags far behind aerospace and power industries, among others. With the exception of the FHWA study previously mentioned research to characterize the reliability of inspection practices for highway bridges have been largely unknown, though research of this type commonplace in many other industries. It should be recognized that there are significant challenges to be overcome, including the limited resources of States for implementing more advanced and comprehensive strategies. A significant effort that includes the contributions of bridge owners and experts from academia and industry will certainly be required.